

TECHNIQUES IN PHYSIOTHERAPY



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PREFACE

THE present volume is an effort to present in as practical a way as possible some of the newer concepts of physical methods and their application to the problems of rheumatism and other medical and surgical ailments. The book is designed to provide the practising physiotherapist with a selected number of techniques that have successfully passed the hard school of actual practice. But those employed by the orthopaedic surgeons have been so fully described in books, films, demonstrations and papers during recent years that the editor has purposely not included a separate chapter on the physical methods employed in the field of orthopaedic surgery. Some techniques and methods which have been found of genuine value in certain aspects of orthopaedics have however been included in the text.

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Much of the material used in the chapter on Occupational Therapy has been taken from Mr Colson's text-book on *Rehabilitation of the Injured*—by kind permission of the publishers Messrs Cassell & Co Ltd. The same applies to the chapter on Suspension Therapy which has been taken from Mrs Cuthrie-Smith's text book *Rehabilitation Re-education and Remedial Exercises* with the kind permission of the author and the publishers Messrs Baillière Tindall & Cox.

The drawings throughout the book have been made by Zita Stead.

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CHAPTER I

IN RHEUMATISM AND ARTHRITIS

THE growing appreciation both by the public and by the Government of the importance of rheumatism and arthritis is a favourable factor. It means not only that cases come earlier for treatment but also that the opportunities for complete cure are greater provided that both the physician and the physiotherapist carry out their respective roles—the one of diagnosis and prescription and the other of efficient physical treatment.

It is essential, therefore, that the physiotherapist should be acquainted with recent advances in matters of diagnosis and combined treatments.

For many years the subject of rheumatology has been in danger of being obscured by a fog of classifications and nomenclatures. It is satisfactory to find that rheumatologists are now moving away from mere names such as lumbago, fibrositis, myalgia, neuralgia and even rheumatoid arthritis and tending to classify these and like conditions in terms of causal factors thus:

- (a) Hereditary
- (b) Psychological.
- (c) Traumatic.
- (d) Biochemical (Fig. 1 Fig. 2 Plate I)
- (e) Bacteriological (Fig. 3 Plate II)

It is of the greatest help to physiotherapists when they find practitioners thinking on such fundamental diagnostic lines.

It is then, of minor significance if a patient's condition is diagnosed as lumbago provided one of the above basic causes is added. Thus we may have lumbago (gout)—thereby putting this automatically into the biochemical group. Again the diagnosis lumbago (^{if} tonsils) is equivalent to the practitioner saying "This patient has a pain in his back of toxic origin, possibly from infected tonsils which I regard with suspicion."

When rheumatic conditions are thought of in this way it does not matter what classification is used—an osteo-arthritis

of the hip that bugbear of all who come into contact with the treatment of rheumatism can be noted as osteo-arthritis (traumatic) or osteo-arthritis (bacteriological) according to the views held by the physician on causation. The great value however of this method is its 'directive' both to the physician and to the physiotherapist as to their lines of treatment.

The rheumatologist having decided which of these basic causes is the dominant factor has a number of further points to settle about each and every case. He has to decide about rest—its extent its duration and where it shall be carried out. Questions of immobilisation and mobilisation have to be considered these may entail the use of splints or orthopaedic intervention. He has to instruct the physiotherapist as to massage exercises electrotherapeutic techniques and hydrotherapy. Home conditions psychological factors occupational therapy or change of occupation, have all got to be considered in addition to removal of septic foci, as well as the use of such potent drugs as gold or high potency vitamins.

In this chapter some of the well recognised names of rheumatic conditions have been retained and the physiotherapist guided as to the best methods to be employed when the case rests either on a traumatic psychological biochemical or bacteriological basis—these four being obviously the underlying causes that more intimately concern her.

The skilled physiotherapist has of course an important function in cases in which psychological factors tend to inhibit progress as is so often the case in rheumatism. She has of course similar responsibilities in all conditions in which psychological factors play their part.

The Physiotherapist's Role

From the physiotherapist's point of view it is best to consider the rheumatic manifestations under three main heads:

- (A) The Mixed Rheumatic Group
- (B) The Non Articular Group
- (C) The Articular Group

(A) The Mixed Rheumatic Group

Cases in this group may be either chiefly non articular or chiefly articular. The most important examples are

- 1 Menopausal rheumatism
- 2 Gout

It is interesting to note that both these conditions have a biochemical cause

(B) The Non articular Group

Cases in this group show minimal involvement of the joints
The chief examples are

- 1 Fibromitis myalgia neuralgias
- 2 Panniculitis

Here the underlying causes may be obviously traumatic biochemical or bacteriological, thus complicating the problem of treatment

(C) The Articular Group

In this group soft-tissue lesions are of secondary importance
It comprises

- 1 Classical rheumatoid arthritis
- 2 Infective arthritis
- 3 Spondylitis
- 4 Osteo-arthritis.

The causal factors in these conditions overlap widely and several may be concerned in any individual case. Experts differ among themselves in their estimates of the relative importance of these factors with the result that in one and the same case some would prescribe rest and others movements. Differences in treatment reflect differences of point of view

A. THE MIXED RHEUMATIC GROUP

1 Menopausal Rheumatism

This condition is primarily and basically one of biochemical imbalance. It may be present for some time before menstruation has ceased, or begin many years after the menopause. When it affects joints these are usually the terminal phalanges (Heberden's Nodes), the knees and ankles. The shoulders, wrists and metacarpo-phalangeal joints are more rarely affected.

More commonly however the condition is entirely extra articular and characterised by stiffness chiefly in the extensors of the thigh the muscles of the lower part of the back and the buttock. This stiffness has one invariable feature—it increases with sitting rather than standing or lying and tends to pass off partly or completely after a few minutes of painful movement. It has therefore been described as the Limbering up Syndrome.

In suitable cases relief—complete or partial—can always be secured by the combined efforts of the physician and the physiotherapist. The former will look after the administration of the appropriate hormones—e.g. oestrogen and thyroid—and supervise diet and habits especially as regards work and rest; the latter will utilise histamine ionisation and exercises to increase metabolism. Thyroid, oestrogen and histamine are therefore all clearly aimed at the basic biochemical causal factors. This is why the results of treatment in this condition are now so much better than they were ten or fifteen years ago before the introduction of treatment by ovarian hormones and histamine ionisation.

Methods of Treatment

The two following methods of treatment will be found useful in this condition.

(i) *Histamine ionisation*—The most suitable method is as follows:

Apparatus required

Any source of direct current

Vaseline

Histamine jelly in an airtight collapsible tube

2 large lint pads

Ether soap

Skin pencil

Rubber glove or finger-stall and appropriate accessories

Method—The area to be treated is cleansed with ether soap and marked out with a skin pencil. Using a rubber glove finger stall or small gauze pad a $\frac{1}{2}$ to $\frac{1}{4}$ in strip of histamine jelly is spread over the area. A pad of 12 thicknesses of lint with electrode and lead is applied over this area and bandaged on. The lead from this pad is con-

nected to the positive terminal of the direct current apparatus. Another similar pad electrode and lead is applied to some other part of the body preferably down the lymphatic stream unless the effect is required very locally when this second pad is applied up-stream or distally. The current is now gradually increased to 4 m.a for the first treatment and given for 5 to 7 minutes later 10 to 15 minutes with 8 m.a may be given. The skin is then again cleansed and dried without rubbing and the patient should rest on a couch for at least 15 minutes 3 times a week is sufficient. Prolonged courses should be avoided as it is only necessary to secure sufficient absorption of the histamine to secure a good clinical response. Not uncommonly much bigger doses are given but they have little or no advantage and may produce headache nausea giddiness and palpitation.

A sign that the treatment has been effective is the appearance of an area of persistent hyperaemia with irregular yellowish patches of urticaria. Flushing of the face or palpitations are indications for stopping the treatment. Sal volatile may be required. This treatment should always be given with the patient lying or reclining on a couch.

Contra indications are low blood pressure excessive sweating and any pre-existing tendency to exophthalmic goitre.

(ii) *Short wave or inducto-thermy coil*—Short wave or the current from an inducto-thermy coil given through the region of the ovaries may be used as an alternative to histamine ionisation when this upsets the patient as it not infrequently does.

Ovarian extract should be given simultaneously and if there is no improvement in symptoms after 4 treatments either the case is not one of menopausal rheumatism or the technique is at fault or a second basic cause is present.

2 Gout

Gout with its many manifestations is sometimes exclusively articular at others it may choose almost any tissue or structure of the body for its chief attack. In its non articular form it may attack the brain the eye the alimentary canal or groups of muscles. The physiotherapist is chiefly concerned however when it appears in joints and muscles.

This condition is basically and essentially a derangement of the biochemical balance of the body metabolism and in particular the skin. From the physiotherapist's point of view procedures that improve the normal functions of the skin yield the most satisfactory results. Indeed, concentration on the rehabilitation of skin function is the real key to success with cases that present the syndrome of gout.

The Syndrome of Gout

The popular impression still exists that patients suffering from gout must have the traditional big toe, a plethoric build of body and a taste for port or other strong drinks. In more scientific circles patients are considered to have gout when the blood uric acid is above 3.5 mgm per 100 c.c. of blood. Both views are completely erroneous. Gout can attack the eye where it is excruciatingly painful or be found invading the tissues of a rigid teetotaller with a flawless character and a scraggy body. It may also be found in patients whose blood uric acid is no higher than 2.5 to 3.0 mgm per 100 c.c.

What then is rheumatic gout? The most practical way to answer this question is to say that this type of gout is that mixture of signs and symptoms that improve when treated by those measures used with success in classical manifestations of gout. This definition begs the question of how it is possible in the absence of the usual classical signs to recognise that a patient is likely to be helped by such measures. Fortunately there are a few clear-cut symptoms, not frequently present in other conditions that are of help. The most valuable of these are statements by the patients such as "The pain comes on when I get hot in bed" or "When the pain is bad I put my arm (or leg) out of bed" or "I get restless and wakeful at about five o'clock in the morning". A history of previous similar attacks of almost equal duration and usually accompanied by the information that I woke with it or it came on while I was dressing (i.e. an early morning onset) also suggests the desirability of treatment directed against gout. Actually all such statements are the equivalent of saying that when the excretive functions of the body especially the skin are less active the symptoms of the condition tend to increase. So if at anything in the history of the patient that indicates freedom from his attacks when his biochemical

functions of elimination are active or a tendency to produce recurrences when conditions have made these functions imperfect points towards a preliminary working diagnosis of gout and indicates the line of treatment that is most effective.

Physical Treatments in Gout

The facts given above constitute the common knowledge and in consequence the livelihood of every spa. Most of the forms of treatment adopted in these institutions aim at the reactivation of the proper functions of the eliminative organs. Thus elimination by the skin is favoured by brine baths spray massage Berthollet treatments or the milder aeration baths followed by packs. Elimination by the liver and the bowel may be achieved by taking the waters sometimes by mouth, sometimes by rectal and colonic lavage sometimes both. Such facilities do not however exist for the great majority of patients nor can the average hospital or physiotherapist in private practice be expected to instal the complicated and expensive installations that are provided by spa corporations.

The physiotherapist in association with the practitioner can however achieve satisfactory results by directing treatment to the following ends:

- Improvement of the patient's skin function
- Securing better elimination of food residues
- Securing suitable intake of solids and fluids
- Administration of drugs that have been found helpful
- Adjustment of the patient's habits

It is of first importance to recognise in the treatment of conditions falling within the above definition that mere sweating of a patient without at the same time raising the temperature at least 1.5 to 2.0° F is valueless. Apparatus achieving sweating plus mild non-fatiguing pyrexia is of value. Turkish baths do not appreciably raise the body temperature—this is why they are of so little value in gouty states. Indeed they may precipitate an attack by the removal of much water vapour.

Methods of producing Mild Pyrexia

- (i) *Radiant-heat or infra red bath*—The most universally available apparatus in hospitals clinics and private treatment

rooms is the radiant-heat bath. This apparatus or its close ally the infra red bath (or tunnel) can with suitable accessories produce satisfactory sweating with a small heat efficient rise of temperature. The essential points to which the physiotherapist should pay attention are as follows:

- (a) A chart should be kept recording the patient's temperature before and after each treatment.
- (b) The body should be well protected from direct radiation as it is this direct radiation that produces symptoms of nausea, tachycardia, depression, anxiety and other unfavourable features.
- (c) Heat losses should be reduced to a minimum by the generous use of blankets over the apparatus. The quicker the patient's temperature rises as a result of these two precautions the better.
- (d) The first treatment should not be given for more than 15 minutes progressing to a maximum of 30 minutes at subsequent treatments. Treatments should not be given more than 3 times weekly.
- (e) If sweating is profuse drinks of normal saline flavoured with lemon should be given in quantity—if sweating is slow and reluctant a drink of sweet spirits of nitre 6-10 drops to a tumbler of water may help—but if sweating does not begin then no attempt should be made to force it until 3 or 4 treatments have been given.
- (f) After every treatment producing even mild pyrexia adequate rest must be secured. The patient should rest for 20 to 30 minutes followed by a shower bath or sponging thoroughly to remove the sweat products left on the skin.
- (g) When fully dressed the patient should rest for a further period of not less than 30 minutes.
- (h) With this form of mild pyrexia as with so many others the patient's symptoms may at first be increased—and such increase indeed is often a favourable sign.
- (i) *Short wave*—An effective method (possibly a more effective one than the preceding) of producing mild pyrexia is by the use of the short wave preferably the inductothermy. The method used with this apparatus is much the same as

when it is used for full hyperpyrexia. The point of prime importance is to prevent the patient's heat losses as far as possible. In the absence of the proper capok bag or cabinet blankets and mackintosh sheets can be used satisfactorily. The application of short wave in whichever form it is essential should be with some concentration over the big blood reservoirs of the body—namely the abdomen and chest. With short wave a suitable method would be after wrapping the patient in two or three blankets and covering these with mackintosh sheets to place two large short wave pads with suitable spacing felts one on the upper chest the other on the low abdomen. The current is applied until the temperature begins to rise 1° to 2 F. This may take at least 40 minutes. As soon as this has occurred the short wave is entirely removed and any rise of temperature (which will go on after the short wave has ceased) is controlled by diminishing the lagging of the patient. In the treatment of the gouty syndrome the temperature should not be allowed to rise more than 3 F.

If true inductotherapy is available the most suitable technique is to apply the coil on the abdomen preferably using the capok bag supplied by the manufacturers.

(ii) *Wilde's vapour bath*—A number of physiotherapists and clinics now possess the pyretic vapour bath designed by the late Dr Percy Wilde of Bath. Where that is available it is definitely preferable to either radiant heat or infra red radiation for producing mild pyrexia and healthy activation of the skin.

When this pyretic bath is in use it is often found that the patient has to pass through a period in which his symptoms are increased before they begin to improve. It is fairly easy to recognise whether adverse symptoms indicate unsuitability for this treatment or merely this passing phase for among those whom this treatment does not suit adverse symptoms appear during or immediately after treatment whereas in those who will eventually benefit from the treatment the adverse symptoms tend to appear some hours later.

(iv) *Sodium bicarbonate and alum baths*—Cases of gout were at one time treated in the home or in small clinics by foam baths and similar types of bath purely with a view to producing sweating. The clinical results of foam baths in cases of gout are on the whole disappointing and are therefore not dealt with here.

In cases of gouty manifestations in the lower extremities however a suitable and efficient simple treatment can be carried out by making up a shallow bath just sufficient to cover the legs with the patient sitting up in the bath with a towel round his shoulders. To this quantity of water should be added 200 grams of sodium bicarbonate and 50 grams of alum. The temperature of the bath should be only 95° F and it should be given for not less than 15 and not more than 30 minutes followed by putting the patient to bed wrapped in a blanket or dry hot towels for 1 hour. These baths which reproduce in a simple form the method and type of water used at Bagneol are of genuine value. They should not be given more than 3 times a week at the maximum.

(v) *Histamine ionisation*—In cases of gout where the non articular manifestations predominate and tend to move about the body histamine ionisation is of value. The technique used is similar to that given on page 4 except that in these cases the active electrode should never be placed on the same part of the body for 2 treatments running, it should move from limb to limb and may be given over the back and the upper abdomen in the region of the liver. If it is found that treatment in the region of the liver is more helpful than elsewhere this may be repeated cautiously, but treatment in this region with histamine is not free from a tendency to a feeling of nausea and faintness.

Better elimination of food residues—This is largely of course a matter for the practitioner but there are one or two ways in which the physiotherapist can give effective help.

Rhythmic surging faradic treatment to all the abdominal and back muscles promotes metabolism and assists in better functioning of the bowel. Such faradic contractions are materially assisted by what is known as the Water Regime. The instructions given to the patient under this regime are as follows:

Two tumblers of cold water preferably with the chill off should be drunk first thing each morning. If possible the amount of water taken should be increased gradually up to four glasses.

You should then lie for 5 minutes on the left side and finally on the right side for 10 minutes before getting up.

If a Thermos flask is filled overnight with hot water it will be found simple to add sufficient hot water from it so that the water you drink is not quite cold

Finally suitably qualified technicians can help the practitioner by the use of the two-way bowel irrigation or of the Stude Chair

The Physician's Sphere in Gout

- Suitable intake of food*
- Administration of drugs*
- Adjustment of habits*

All these belong to the sphere of the practitioner. When physicians are employing physiotherapists for the treatment of gouty conditions the following preparation given intra muscularly once or twice a week by him during treatment will be found to accelerate the benefits derived from physical treatments.

Quinophan with Procaine

Each c.c. contains	
Cinephenum Sodium	5 per cent w/v
Procaine Hydrochloridum	1.5 per cent w/v
Acidum Formicum 25 per cent	3-100 000
Aqua Dest	ad. 1 c.c.

B THE NON ARTICULAR GROUP WITH MINIMAL JOINT AFFECTION

1 Fibrositis Myalgias Neuralgias

These conditions have been grouped together as they have eluded accurate definition either in terms of their etiology or of their pathology. It is possible that in the not distant future the electromyograph will begin to unravel the interesting problems they present. It is quite impossible to put against any one of them a single basic underlying cause. They may be therefore traumatic or possibly biochemical certainly often infective and sometimes a combination of all three. It helps to compare the type of physical treatment most suitable to cases predominantly based on trauma with those treatments of value in infective processes or in cases with a biochemical foundation.

Treatment

Cases of fibrositis myalgia or neuralgia primarily traumatic in origin are benefited by heat *plus* stimulation. The heat may be applied either by suitable baths or by paraffin wax radiant-heat infra red or short-wave and it may be associated with currents of the faradio type or with rehabilitation exercises carried out by the patients themselves. For these cases massage in all its forms is often of the greatest help and provided that deep frictions do not add to the damage to the tissues it is sometimes the only method found effective in removing residual pain after injury and the so-called nodules of fibrositis.

The response of patients to treatment on these lines will itself indicate the correctness of the initial diagnosis because those who are going to respond favourably gain by each treatment and those whose condition has some other basic cause, such as a chronic infective process will either go forward two steps and back two or actually retrogress as treatment proceeds. Treatment as outlined above therefore can be legitimately regarded as diagnostic and the response should be reported to the practitioner on these lines.

When fibrositis myalgia or neuralgia has a basic infective origin anything in the nature of strong contractions of muscles for any lengthy period is contraindicated until the focal source of the poison has been successfully eliminated or neutralised. In these cases pain actually increases during treatment and so provides a useful warning signal. If elimination or neutralisation of the causative focus is not feasible it is still possible to bring some measure of relief to these patients by such methods as intensive irradiation with ultra violet light preferably by the Kromayer lamp (page 19 *as for deltoid*) or by the application of short-wave diathermy to the most affected areas.

Massage in these cases should be of the type of effleurage and gentle petrissage and all frictions or deep kneading should be avoided.

Where a biochemical basic cause exists for these conditions, the treatment is precisely the same as suggested below for panniculitis.

Recently Copeman and Ackerman have advanced an entirely new conception of fibrositis of the back. From careful anatomical dissections and biopsies they conclude that the basic origin

of established cases of fibrosis lies in an increase of tension in the fat lobules where they are invested by a non-distensible fibrous membrane. They have succeeded in relieving a number of cases either by operation on these constricted fat lobules or by suitable infiltration of their areas by solutions of local anaesthetics.

2 Panniculitis

The basic underlying cause of panniculitis is biochemical. The metabolism of the body is sluggish much as it is in myxœdema. The predominant signs of this painful and debilitating condition are familiar to all physiotherapists. It is one of the few conditions in which massage may be applied so vigorously as to produce considerable discomfort.

Treatment

It is however clear from the nature of this condition that just as in the case of soft-tissue gout good elimination by the skin is necessary. Sweat baths, preferably of the Wilde's pyretic type or spa baths if available should be prescribed provided that sweating at a slightly raised temperature is secured. If neither of these baths can be procured, infra red baths as described (page 7) may be used.

Histamine ionisation is of great value and in these cases dosage should always be pushed until generalised symptoms are experienced either of facial flushing or increased pulse rate. Here the reason for the high dosage of histamine is that panniculitis is a slow chronic condition affecting the superficial fatty layer of the body which is in any case relatively poorly supplied with blood and therefore less easily reached by this drug. This is another type of rheumatism that is materially improved by active collaboration with the physician in charge. Bad habits—e.g. excessive smoking or drinking—must be controlled—the quantity of food and liquids taken in must be regulated and attention given to the hygiene of the bowel.

C. THE ARTICULAR GROUP

1 Classical Rheumatoid Arthritis

There has been much dispute about this distressing manifestation of arthritis. For the purpose of intelligent selection

of physiotherapeutic procedures it is best to consider this condition as probably basically infective but with the infection grafted on to a sensitive or already deranged biochemical mechanism.

The infective element is from many points of view strongly suggestive of a chronic tubercular infection. The value of this particular conception is that many of the methods utilised in the treatment of active lung disease are valuable in rheumatoid arthritis—rest freedom from worry careful attention to nutrition and the judicious use of vitamins and of ultra violet light are of value in rheumatoid arthritis just as much as they are in active tuberculosis of the lung. To this list may be added the use of gold injections.

In rheumatoid arthritis one of the most important and earliest considerations is to decide what measure of immobilisation should be applied to an affected joint. There are certain general rules laid down by the late Dr Coates of Bath in regard to the immobilisation of the affected joints of rheumatoid arthritis or infective arthritis which still apply. These are that a joint affected by rheumatoid arthritis should, if possible be immobilised in the early stages and long before contraction deformities have occurred that such immobilisation should be effected at first only by light night or rest splints made of plaster of Paris and capable of easy application and removal from the limb (or limbs) that in no circumstances should such splints be maintained for longer than 8 hours at first that the maximum period without removal should never exceed 72 hours and that this 72 hours should only be reached by a gradual extension of time from the original 8 hours and then only when the response to such immobilisation is good—namely relief of pain diminution of swelling and increase of range of movement. The appearance of adverse symptoms namely increase of pain or swelling and increasing deformity is an indication that the progression of immobilisation or the fitting of the splint has been unsuitable. It may be necessary during this period to make three or four fresh splints to meet the changes in contraction and in the contours of the limb brought about by the decrease of spasm and swelling.

Plaster splints for rheumatic cases must be considerably lighter than those generally used by orthopaedic surgeons, easy of removal high in the sides without encircling the limb and

when firmly set be as near as possible to the position of optimum function.

Suitable rest and immobilisation being secured a second essential is that physiotherapeutic measures should only be employed with great caution when the haemoglobin is definitely below 70 per cent. It is entirely justifiable in such cases for the physician to give an intravenous transfusion of a pint of whole blood. By doing this he frequently alters the whole response of the patient to physical measures. The date of the transfusion often marking a turning point for the better in the progress of the disease.

Treatment

In rheumatoid arthritis where the blood sedimentation rate is high the haemoglobin content low and immobilising splints are required, the initial physiotherapeutic current should be the 4-cell schnee current with normal saline in all the four baths the legs usually being made positive and the arms negative. If the joint-changes strongly predominate in the arms they should be made positive rather than negative. The current should be only 3 to 5 mA given 15 minutes daily for a fortnight. After this initial course of treatment the patient should be sufficiently improved to benefit from the gradual introduction of very small quantities of surging sinusoidal current through the same 4-cell schnee baths. During this second phase according to the response and condition of the patient joints may be singled out for the application of paraffin wax (see Chapter 9). As soon as the haemoglobin is well above 70 per cent general ultra violet light in very small doses can be tolerated but it cannot be too strongly stated that in the presence of a high blood-sedimentation rate and a low haemoglobin large doses of ultra violet light whether from the natural sun or from artificial sources are definitely harmful. The use of infra red radiant heat or large doses of short wave are as definitely harmful and contraindicated as they are in cases of shock.

The important thing to remember is that rheumatoid arthritis is a serious disease with a prognosis largely dependent upon the treatment given by the physician and the physio-therapist. They both bear a heavy responsibility not only for the maintenance of the patient's general health but for the prevention of crippling deformities.

(i) *Aeration baths*—Aeration baths are also of definite value even in severe cases of rheumatoid arthritis provided that the patient can be placed in the bath without undue pain. The apparatus required to give the bath is so simple that it can easily and with small expense be installed in any small clinic or hospital or even in the patient's home. It need only consist of a very small air pump connected to a series of tubes with holes. This is placed in the bottom of the bath with a suitable wood grid above it. A sling should be fitted across the bath at the head end so that the patient can lie with the head supported and obtain full relaxation. For these cases the temperature of the bath should be 98° F. As the aeration tends to cool the water quickly it may be necessary to stabilise the temperature once or twice during the period of immersion which should last from 10 to 20 minutes. After the bath the patient should be wrapped in a blanket pack for half an hour. The equipment and procedure for this is

1 pillow

2 blankets

1 warm large twill sheet or turkish towel

1 warm small towel.

A couch or bed is prepared with the pillow and one out-spread blanket. The warmed small towel is placed over the patient's chest and abdomen. He is then enveloped in the warm sheet and taken to lie on the couch. The small towel is drawn from under the sheet and used to wrap up the feet. The sides of the under blanket are brought across the body and tucked in one side over the other. The second blanket is then spread over the patient and tucked in round the sides and under the feet. The sheet should be folded over the blanket round the neck to prevent discomfort. He remains like this for half an hour.

When the patient has dressed, a further period of half an hour should elapse before going into the open air and it is an advantage if a warm drink can be provided. These aeration baths and hot-blanket packs should not be given more than three times weekly.

(ii) *Massage*—Massage of the most gentle effleurage type merely sufficient to secure interchange in the tissues is of help. All other forms and particularly passive stretching are definitely a menace to recovery and progress.

2 Infective Arthritis

It is unfortunate that cases of infective arthritis so often yield unsatisfactorily to the removal even of obvious foci of infection. It is necessary therefore to consider whether in these cases as well as the dominant and obvious infective basis there is not also another of the basic causes at work. In this connection further research may bring to light hitherto unknown etiological factors—whether hereditary, psychological or biochemical.

Gonococcal infection is responsible for one of the most crippling forms of infective arthritis. Fortunately however the treatment of gonococcal arthritis has improved out of all knowledge within recent years. Reports from America on treatment with a combination of penicillin, sulphanilamide and hyperpyrexia suggest that it may be possible to look forward to a complete and radical cure of this disease.

The problem of the treatment of an infected joint lies of course primarily with the practitioner but particularly when an infective arthritis is present in one joint only electrotherapeutic currents are of value.

Treatment

It has been shown elsewhere that short-wave treatment is of value in the treatment of arthritis and boils because it deals by means of deep fomentation with inflammation to which this current can gain access. So also in the case of the single arthritic joint it is possible by sound technique to use short-wave to assist the process of repair during the course of the acute inflammation. Clinical experience suggests that in single joints the inductive thermic coil surrounding the joint produces the best results. It should be given daily and in acute cases that are under proper bedded conditions twice a day and the short-wave should be taken to the patient rather than the patient to the short wave as rest is of such primary importance.

In the more chronically infected joints especially where thickening has occurred in the capsule and where there is limitation of range of movement by such thickening rather than by effusion paraffin wax is of value especially when applied as bandages (page 172). The range of movement can often be increased by spring suspension exercises.

The Peri-artritic Shoulder

Orthopaedic surgeons recognise an interesting condition occurring in the shoulder which owing to the nature of the course it runs appears to have a true basic infective origin but a number of cases have been excited to activity by recent minor trauma. This condition is known as peri-articular arthritis or the frozen shoulder. It is a condition found in women more commonly than in men and patients are usually over the age of 40. It may therefore be necessary to consider also whether a biochemical factor enters into these cases. The onset as mentioned above is frequently but by no means always associated with trauma. The condition runs a very definite course lasting a period of weeks or months the symptoms gradually increasing in severity and as gradually subsiding. With correct treatment most cases recover completely.

Clinical Features

Pain is usually referred to the insertion of the deltoid in the upper third of the shaft of the humerus. There is usually considerable spasm of the shoulder muscles and all movements of the shoulder are limited particularly abduction and external rotation. If movement is not encouraged a frozen shoulder will be the end result.

Injudicious treatment in the acute stage will inevitably aggravate the symptoms. Massage to the shoulder and frequent passive stretching will lead to the formation of adhesions and further limitation of movements.

Treatment

Treatment in the acute stage should be limited to radiant-heat or short-wave and gentle active exercises carried out frequently during the day. When the acute symptoms have subsided and no further improvement in range of movement is being obtained then gentle manipulation under an anaesthetic should be considered. This should be in the nature of a stretching rather than any forcible manipulation.

Massage in any form is contra indicated—the essence of treatment is active exercises performed frequently during the day.

These cases frequently respond to third degree erythema doses by the direct face of the Kromayer lamp all round the shoulder and deltoid. Before applying the Kromayer lamp the skin should be swabbed with ether. Following the application the whole area so treated is immediately covered with 2 layers of elastoplast which must not be removed for 10 days. If oozing occurs through the dressing it should be covered with a further layer.

3 Spondylitis

The basic cause of spondylitis is unknown. The late Gilbert Scott regarded all cases of spondylitis whether of the wasting type or the type associated with overgrowth of bone as gonococcal in origin. The evidence for this view seems to be most inadequate and it is not possible to accept it.

Treatment

Physiotherapeutic measures are of little or no value from the standpoint of cure nor does the removal of sepsis help. Deep X-ray therapy appears to check the progress of this disease in a number of cases but is in no sense curative. The greatest advance in the amelioration of symptoms is secured by the intelligent regular and persistent use of suspension therapy in association with deep X-ray therapy (page 126). When the suspension therapy apparatus is not available it is of first importance to maintain movement of the patient's back, and particularly the articulations of the ribs for as long as possible. Very careful head suspension is sometimes helpful, using the standard apparatus. The patient should be in the sitting position and the trunk is then raised slowly until the buttocks are just touching the seat. The position should not be held for longer than 30 seconds and the release of the patient to the starting position should be equally slow and careful. This should be regarded as a definite exercise from which progression in number of suspensions and in duration of the actual period of suspension is effected according to the ability of the patient to remain relaxed. Head suspension that produces antagonistic muscle spasm is merely defeating its own object. Massage and exercises provided they produce no fatigue and provided they are carried out regularly are of genuine value. Diathermy, faradism and other electrical treat-

ments though they may have a temporary palliative effect do not secure any lasting improvement. Subcutaneous injections of oxygen on either side of the spine by the physician followed immediately by short-wave from the base of the neck to the buttocks is frequently a helpful technique.

But the important point in these sad cases is to vary technique and currents and to keep up the patient's spirits. If they are allowed to get more and more fixed and more and more kyphotic their ribs move less and less with each degree of flexion of the spine and eventually a quite small attack of bronchitis or pneumonia is likely to prove fatal because the range of movement of the ribs at their vertebral joints has become seriously restricted.

4 Osteo-arthritis with Special Reference to Osteo arthritis of the Hip-Joints

Osteo arthritis is perhaps the commonest of all forms of chronic arthritis. Its onset is insidious—the degenerative process in a joint usually slow—is hastened by excessive use or trauma—but in spite of practically all treatment and precautions the progress of the disease remains unaffected.

The condition is one which calls for the closest collaboration between the physician the orthopaedic surgeon and the physiotherapist. In the following paragraphs osteo-arthritis of the hip joint is taken as a typical example.

The degenerative process usually starts in the articular cartilage. Over the weight-bearing surface the cartilage becomes thinned and eroded while the peripheral cartilage is undergoing hypertrophic changes. Ossification gradually occurs in the hypertrophic peripheral cartilage giving the characteristic lipping which is so constantly demonstrated by X rays. The synovial membrane is affected becoming thickened and hypertrophied. The synovial fluid may be increased and loose bodies develop. The capsulo and ligaments are finally involved in the degenerative process and become contracted and predispose to insecurity and limitation of the movements of the joint. The muscles in the region of the joint undergo marked wasting fibrosis and loss of power. This is a characteristic feature of this disease.

The two main symptoms which bring the patient to seek

advice are pain and increasing limitation of movement. In the late stages increasing deformity is an added symptom particularly flexion deformity adductor spasm and external rotation of the hip-joint.

Treatment

In a slowly progressive disease there can obviously be no hard and fast rules nor as yet is there one settled line of treatment. For convenience patients may be classified into two groups:

(i) Cases in the early stage of the disease when treatment is conservative and palliative. In this stage surgery with a few exceptions has no place in active treatment.

(ii) Cases in the late stage. Depending on the age, general condition and occupation of the patient surgery can offer much in the relief of pain and deformity. The pros and cons of an osteotomy, arthrodesis and arthroplasty have to be carefully considered but each has its place in the treatment of osteo-arthritis.

(i) *Treatment in the early stages*—Apart from the post-operative treatment it is in the comparatively early stage that physiotherapy is usefully employed. The aim of treatment in this stage is relief of pain and prevention of deformity.

Immobilisation of an osteo-arthritic joint by splinting will lead to further limitation of movement and therefore deformity must be prevented by active muscular control. Opposing groups of muscles must be properly balanced and any loss of tone and power in a particular group restored by treatment.

Pain may be alleviated by various forms of radiant heat infra red and short-wave diathermy. For smaller joints such as the hand wax baths are of great value. Deep X rays have a limited value in the relief of pain but in some cases particularly in those demonstrating peri-articular thickening pain is sometimes considerably relieved. When deformity is present deep pool baths when available are particularly useful for relieving muscle spasm and increasing movements.

For the maintenance of muscle tone and the prevention of deformities faradism and active exercises play by far the most important role. These can be assisted by the use of suspension therapy and where this is not available other mechanical devices such as rowing machines and bicycles.

(ii) *Treatment in the later stages*—Some of these are benefited

hy a gentle stretching and manipulation under an anaesthetic. The patient is then immediately sent for infra red or short wave therapy and the use of the suspension apparatus. The pain is sometimes considerably relieved and an increased range of movement obtained. Unfortunately however the improvement is usually only temporary.

Operative Procedures

Arthrodesis of the Hip

(a) *By Smith Petersen nailing*—When osteo-arthritis involves one hip joint only and the range of movement at the hip-joint is limited to 20° or less with only a little fixed deformity present then relief from symptoms can be obtained hy an arthrodesis with the Smith Petersen nail. Relief of pain is immediate and the patient can be allowed to walk with crutches directly the stitches have been removed in 10 to 14 days but full weight bearing is not usually allowed for about 3 months. Physiotherapy should begin as soon as the patient has recovered from the post-operative disturbance, usually in 2 or 3 days.

Active exercises for both feet and ankles and the knee and hip of the sound leg should be instituted from the beginning. When treating the affected leg it must be remembered that it is essential to maintain the full range of movement of the knee joint but throughout treatment great care is necessary especially when treating the quadriceps so that the nail is protected from any undue leverage otherwise it will loosen and pain will return. Exercise may be given with safety if the patient is moved so that the lower leg is suspended over the side of the bed and supported by the physiotherapist whilst active flexion and extension of the knee is performed. The patient should also be instructed to carry out static contractions of both quadriceps for 5 minutes hourly. Particular attention should be given to maintaining the tone of the back muscles and glutei.

As soon as the patient is allowed np re-education of walking with the use of crutches should be taught with or without minimal weight bearing as the surgeon may decide.

(b) *Intra-articular arthrodesis and Smith Petersen nailing*—When a fair range of movement is present in the hip-joint but

also considerable fixed deformity usually a flexion and adduction deformity a firm arthrodesis is best obtained by a two-stage operation.

At the first operation the intra articular arthrodesis is performed by removal of the cartilage from the head of the femur and the acetabulum thus allows correction of all the deformities. The hip-joint is then immobilised in a full hip spica in the optimum position for ankyloosing.

The second operation is performed a month to 6 weeks later when a Smith Petersen nail is inserted and a short hip spica reaching to just above the knee joint is applied for a further 4 to 6 weeks. During this period the patient is allowed to walk with crutches modified weight bearing being allowed on the affected leg.

This combined operation has the advantage that the period of convalescence in plaster is considerably shorter than when an intra articular arthrodesis without nailing is performed.

Physiotherapy should begin as soon as possible after each stage of the operation.

After the first stage active exercises for both feet and ankles and for the knee and hip of the sound leg should be instituted from the beginning.

Static contractions of all the muscles of both legs should be taught and the patient should be encouraged to carry them out at regular intervals during the day for the period that he is in plaster.

As the plaster has to be taken as high as the chest in order to prevent adduction of the hip special attention should also be given to breathing and arm exercises.

After the second stage the knee is gently and progressively mobilised and wax packs or bandages may be found useful in helping to prevent stiffness. The patient must also be taught to walk with the use of crutches.

McMurray's Osteotomy

For the relief of pain and the correction of deformity some authorities prefer a displacement osteotomy which has the advantage that it is a comparatively minor operation as compared with an intra-articular arthrodesis and the patient is also left with a certain amount of movement at the hip joint.

Following an osteotomy a hip spica is applied which is usually retained for about 12 weeks.

Physiotherapy should be started as soon as the patient has recovered from the post-operative disturbance and is the same as for an intra articular arthrodesis.

Owing to the long period of immobilisation in plaster the knee-joint inevitably becomes stiff. It is possible to reduce this residual stiffness to some extent by the use of the surging sinusoidal current given from foot to foot. This current should be given daily at a strength only just sufficient to bring an appreciation of tone into the muscles of the normal leg i.e. not at such strength as to cause movement at the joint. The rhythmical pulses necessary to and always present in healthy muscles are thus reproduced to a certain extent.

The plaster is usually bivalved after 8 weeks to just above the knee-joint and the back portion is cut across so that it can be removed. The patient may then be turned on to his face and gentle mobilisation of the knee-joint started without endangering the fixation of the bone. The back portion of the plaster must be replaced immediately after treatment.

If the X ray is satisfactory the patient is usually allowed up on crutches without weight bearing on the affected leg in about 14 weeks. Physiotherapy should proceed along the lines described for arthrodesis by nailing.

Full weight bearing is allowed when the X ray shows firm consolidation of the bone.

Excision of the Head and Neck of the Femur

When a bilateral osteo-arthritis is present with ankylosis of both hip joints an excision of the head and neck of the femur gives a certain range of painless useful movement to one hip although many patients have to wear a walking appliance.

Post-operative treatment varies with individual surgeons. One method is to immobilise the affected leg by means of a Steimann's extension pin through the tibia, and a plaster hip spica for 4 weeks after which the plaster is removed and strapping and extension applied for a further period of 4 weeks. The extension is then removed and the patient is allowed to walk with the aid of a caliper which may be discarded at some later date.

Physiotherapy should begin as soon as possible after the operation. Active exercises for both feet and ankles and static contractions for all the muscles of both legs should be practised at frequent intervals of each day. It is essential to maintain the range of movement of the knee-joint of the sound leg. This is often difficult owing to lack of movement at the hip-joint but if the patient is nursed on a Pearson bed a section of the mattress and one of the canvas strips can be removed at each treatment period so that the knee can be easily flexed and extended.

After 4 weeks when the plaster is removed, active movements of the knee and hip-joints must be encouraged particularly flexion of both joints and abduction of the hip. The patient must realise that a good result will only be obtained by continuous efforts at movement throughout the day. Abduction of the hip can be assisted by means of suspension slings and the following device has been found useful for assisting flexion of the knee and hip. A sling is placed under the knee and attached by stout cord to an overhead pulley screwed to a balkan beam. A wooden handle is fixed to the free end of the cord which the patient can grip. A roller skate is then attached to the heel, and a flat wooden board about 2 ft long is placed on the mattress under the foot. The patient exercises his leg by pulling on the handle attached to the knee pulley. This movement is assisted by the action of the roller skate at the same time the patient should try to increase the range of movement by active muscle contractions.

As soon as the patient is allowed up he must be taught to walk with the use of caliper and crutches the crutches are discarded when the patient has a stable gait.

The surgical treatment of this distressing and crippling condition is being constantly modified. At one time the use of vitellium cups looked extremely hopeful but this method has not yet achieved such success as to justify its universal introduction.

Similarly other methods have other advocates. All these procedures however are purely palliative and unfortunately there is no evidence that any genuine advance has yet been made towards the discovery of the true causes of this condition and their elimination.

Lactic Acid Injections

Recently the treatment of osteo arthritic joints by the intra-articular injection of lactic acid with procaine looks as if it might be an alternative to some orthopaedic surgery for affected joints especially those of the hip. This treatment was introduced and developed by Mr Grant Waugh F.R.C.S. of Sunderland. It has much to commend it both as regards its principles and its results and compares favourably in its long term results with any or all surgical measures. These results are materially enhanced when immediately after each injection and between the injections the joint is subjected to voluntary weightless movements on the suspension therapy apparatus.

Recent work has shown that passive extension with abduction and weights of varying poundage may be of great value in selected cases.

CHAPTER 2

IN SOME NERVE CONDITIONS

PHYSICAL methods play a vital part in the diagnosis and treatment of many nerve lesions, and in the recovery of the patient. The faradic and galvanic tests still have their place in the diagnosis of lesions of the motor neurones and refinements have been made possible by improvements in the designs of stimulators.

Electromyography is an interesting advance in methods of diagnosis of lower motor neurone lesions and there are indications that it might prove of value in prognosis. However in the light of present knowledge the routine use of electromyography does supersede the older methods of electro-diagnosis.

The Quinizarin sweating test devised by Dr L. Guttmann (*J. Neurol. and Psych.* 1940 in, 197) provides a simple and objective method of assessing the extent and degree of damage to cutaneous nerves. Furthermore by serial examinations it gives reliable information of the absence or progress of recovery in the autonomous zone of the nerve and of recovery due to overlap by adjacent nerves.

PERIPHERAL NERVE LESIONS

The Faradic and Galvanic Tests

Dr Wilfred Harris (1943)¹ defines tersely and well the limits within which the ordinary faradic and galvanic muscle test may be trusted.

If the muscular contractions are still active to faradism 10 days after the damage has occurred it is quite certain that the nerve injury is slight and will recover. At the same time the contractions to the galvanic current will be brisk, not sluggish. The polar reaction whether A.C.C or K.C.C is the greater is of little importance. If faradic muscular irritability is totally lost 10 days

¹ *Brit. Med. J.*, 1943, ii, 823

after the onset of the palsy and the galvanic reactions become sluggish then we know at once that the lesion is severe, and will lead to marked secondary contracture with over-action, and only partial recovery. If in addition to the faradic loss the galvanic reactions after a period of hyperexcitability slowly diminish after 4 to 6 weeks then no recovery at all is likely. The only exception is when a nerve is damaged by compression, as may happen from scar or by a haemorrhage in the bony canal. Here the loss of faradic irritability and the presence of full reaction of degeneration described above prove a severe lesion, which will be followed either by no recovery or only slight and accompanied by severe contracture and perhaps clonic spasm unless the nerve is decompressed or grafted.

If these limitations are borne in mind the faradic and galvanic (i.e. pulse D C) muscle test yields useful and valuable information.

The practitioner whether surgeon or physician should be present at every muscle test on the results of which an operation may be advised. This is extremely important for what he sees will materially help him to form a judgement.

In testing the excitability of any tissue many factors have to be considered amongst them the nature strength and duration of the stimulus to be applied. In clinical work every one is familiar with the use of electrical stimulation faradism and galvanism are usually employed. The faradic current provides rapidly repeated stimuli of short duration (1/600-1/1000th sec.) with galvanism the impulses are of the order of one second's duration the strength of the stimuli can be varied. A tissue that is readily excitable will respond to currents of short duration and relatively low intensities whereas one that is less easily excitable will either fail to respond to stimuli of short duration or will only do so if the strength of the current is greatly increased. These facts form the basis of the electro-diagnosis tests in common usage.

A normal muscle can be made to contract by a faradic stimulus of low intensity when this is applied to the overlying skin. However in such a muscle the nerve supply is intact and the current stimulates the nerve fibres. If the impulses that are set up in the nerve trunk are sufficient in number and intensity the muscle will respond by contracting. The nerve twigs conduct the impulse rapidly and over a wide area, and the muscle fibres in many motor units contract at the same

time or almost the same instant. The response of the muscle can therefore be graded according to requirements.

In degenerative lower motor neurone lesions the affected muscles have lost the whole or part of their nerve supply and by 3 days after the injury it is no longer possible to excite a contraction by stimulation over the course of the nerve trunk itself below the level of the damage and the muscle becomes more difficult to stimulate with the percutaneous faradic current applied over its surface. Indeed by 10 to 14 days after the injury the faradic response may be completely lost on percutaneous stimulation or it may be very feeble and only obtained by using abnormally high currents. (Where the muscle is exposed at operation without the intervention of skin and overlying structures, it is still possible to elicit a response to faradism by direct stimulation of the muscle provided that it has not undergone serious structural changes due to denervation.) Whilst after denervation there is loss or grave alterations in the type of the faradic response it is still possible to stimulate the muscle with currents of long duration e.g. galvanism. The nature of the galvanic response alters and instead of a brisk contraction and relaxation these become sluggish in character. A possible explanation is that in this denervated state the muscle fibres need a longer build up time and the sluggish relaxation may be due to the fact that some fibres are still contracted whilst others are relaxing.

The commonest method of reporting a muscle test is to divide it into faradic and galvanic and to report the faradic responses as present or full diminished or absent. When the faradic response is present and the galvanic response is sluggish a report of P.R.D. (partial reaction of degeneration) is made. When the faradic response is absent and the galvanic response is sluggish the report is R.D. When neither a faradic nor galvanic response is obtained the report should be absolute R.D.

Now and again freak reactions are seen such as full recovery in cases with complete R.D. A discussion of this does not come within the scope of this book but it stresses the point that the electrical reactions of a muscle or group of muscles are not by any means always an accurate or conclusive proof of the condition of the nerve. For instance oedema in the tissues over a normal muscle may prevent its responding to electrical stimu-

lation When oedema is present therefore the absence of a galvanic response is not necessarily very significant Some attempt should be made to reduce the oedema before reporting the electrical reactions If however there is no oedema and if muscles are grossly wasted and there is no response to galvanism the muscle fibres have probably suffered irreversible changes

When a nerve is recovering voluntary power often returns before a faradio response can be obtained However standardised testing with the stimulator designed by Bauwens has shown that the greater proportion of cases recover excitability to short duration stimuli before voluntary power returns It is noteworthy that the response is small and requires an abnormally large current The reason may be this it will be recalled that when a normal muscle contracts on stimulation through the skin with faradism it responds to impulses transmitted by the intramuscular nerve twigs When an injured nerve fibre reaches a certain stage of recovery it may be able to conduct impulses throughout its length whilst it cannot be excited artificially throughout its length i.e. as the current is applied further away from the lesion towards the extremity it becomes more difficult and even impossible to excite the nerve Recovering nerve fibres may therefore be able to carry natural voluntary impulses strong enough to make the muscle contract before the terminal fibres in the muscle are sensitive enough to respond to the artificial stimulus of a faradio current

The practitioner who carries out many tests may prefer to work with two small button like electrodes held in one hand about half an inch apart By this means he can concentrate on an individual muscle without disturbing its neighbours He also has the other hand free for adjusting the patient or apparatus or for palpating the muscles and tendons which he is testing

A patient who is to be tested should be made warm and comfortable and the test should be finished as quickly as possible

The Electromyograph

The electromyograph represents an outstanding recent advance in the investigation of lower motor neurone lesions It demonstrates minute variations in the action potentials in

muscle. It consists of a very sensitive amplifying apparatus to which is connected a special concentric bipolar needle electrode. This is inserted into the muscle to be tested and conducts the tiny muscle-current into leads whence they flow to the amplifier. These variations may be shown as deflections of the beam of light in a cathode-ray tube or as variations of sound when a radio loud-speaker is connected to the amplifier.

Three kinds of action potential are found and they have a characteristic appearance and sound.

- (1) The normal motor unit action potential
- (2) The small fibrillation action potential, which is found only in degenerative lower motor neurone lesions
- (3) The highly polyphasic motor unit action potential which is sometimes found in normal muscles but more usually in muscles whose nerve fibres have been damaged and have grown back to them again and established functional connection.

The electromyograph will not yet measure accurately and quantitatively the extent to which the damaged nerve fibres have resumed their work, i.e. the amount of reinnervation that has occurred in the muscle. Where a series of examinations has been made it does give the earliest indication that the muscle now contains new nerve fibres which are mature enough to cause a contraction in the muscle fibres which they supply. The interval between the return of motor units and recovery of voluntary power varies with the type of injury in the nerve. It must be stressed that a single finding of motor unit action potentials does not guarantee useful recovery. It indicates either that some regenerated fibres have reached the muscle or possibly that some fibres have escaped injury or that the muscle has an anomalous supply from another main nerve trunk. When the muscle is recovering satisfactorily however each test shows more action potentials than the one before not only in a single muscle but in muscles previously denervated.

Sometimes the electromyograph will not record any action potentials in a muscle which is already contracting voluntarily. The explanation is usually that the needle has been inserted into scar tissue or the new nerve supply is patchy so that some areas are still not yet reinnervated. If no matter where the needle is inserted—always provided that there is no defect in the instrument—no action potential can be detected the

movement is not a true contraction but comes from some other muscle

A typical case in which the electromyograph is invaluable is a Bell's facial palsy of the idiopathic type. The muscles which are going to recover completely are silent. In those muscles whose nerve supply has degenerated fibrillation will be found after about 3 weeks.

Like the earlier apparatus of course the electromyograph has its limitations. Electromyography still cannot replace the faradic and galvanic tests for the *initial diagnosis* immediately after the nerve has been injured. The fibrillation which characterises a degenerative lesion may not appear on the electromyograph for 3 or 4 weeks but the progressive failure of nerve conduction below the lesion starts to affect the faradic and galvanic responses almost at once and nerve conduction has usually disappeared by the 3rd day. The alterations of the reactions of muscles themselves can be followed both qualitatively and to some extent quantitatively and by the 10th to 14th day the change is quite characteristic.

In cases of minimal denervation where the damage to the nerve supply is only very slight the electromyograph scores over the faradic and galvanic tests. Whether it is better in such cases than Dr Bauwen's special apparatus or not so good is still disputed. The department at the Military Hospital for Head Injuries at Oxford says it is better. At the Wingfield Morris Orthopaedic Hospital, however, it has been found that it may not invariably give as good information as the Bauwen's apparatus but that the shorter time taken to perform an adequate examination is decidedly in its favour. The electromyograph will not indicate *anomalies* of innervation at all and so here the older methods still hold the field. On the other hand it gives an additional invaluable service in distinguishing between organic and functional nerve lesions.

The Quinizarin Test

The power of the skin to secrete sweat varies with the condition of the nerve lying beneath it. Quinizarin is a dye which changes colour in contact with moisture and the quinizarin test is one of the simplest and most satisfactory methods of studying the alteration of sweat secretion in various condi-

tions It is particularly valuable in following recovery after peripheral nerve injuries

Quinizarin Compound (Wellcome) is a reddish-grey powder containing 28 per cent of quinizarin and 28 disulphonic acid. The remainder is rice starch which dilutes the quinizarin and makes it easier to apply but does not play any part in the test. When sweating occurs the skin where powdered takes on a dark violet colour and the openings of the sweat ducts show up as minute dark dots contrasting with the dry areas which remain uncoloured. The dye washes off easily with water.

The patient is first given 5 to 10 grains of aspirin and also one or two cups of hot tea to promote sweating. The dry powder is taken up with a pad of cotton wool and dabbed evenly on to the area to be investigated. Sufficient pressure is used to ensure that the openings of the sweat ducts are filled with powder. The application must be thorough and the powder evenly distributed particularly on the hands and the sides of the fingers. Special care should be taken in powdering the face to prevent tears or sneezing the eyes should be kept closed.

The next step is to place the patient in a radiant heat cabinet for 15 to 45 minutes until he sweats profusely. Then particularly in peripheral nerve lesions careful observation should be made of the onset amount and distribution of sweat secretion both in the area supplied by the damaged nerve and its adjacent nerve and in the corresponding parts on the opposite side of the body. In some cases the observer should note the order in which different areas begin to sweat and the relative intensities of the sweating over them. He must observe the patient continuously all the time the test is being made so as not to be misled by sweat running on to non sweating areas. Fig 4 (a) and (b) show the skin of a hand shortly before suture of the median nerve and 8 months after suture.

The interpretation of the test is essentially a procedure for the physician or surgeon in charge of the case but the physiotherapist should be familiar with the technique as she may be required to assist in carrying it out and the findings may affect her own work on the patient. The value of the test lies in the fact that where a nerve is recovering the area of skin supplied by it recovers its sweating activity before

sensation returns. The relation of recovery of sweating and voluntary movement is dependent amongst other things on the level of injury and will vary in each particular nerve. An in-

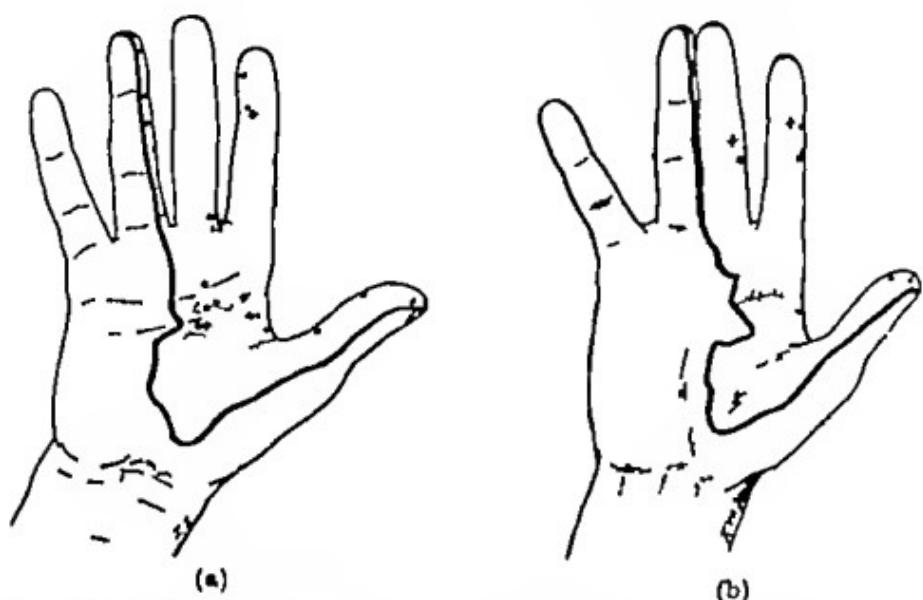


FIG. 4 (a)—Complete lesion of the median nerve in the upper third of the forearm due to a gunshot injury. Sweat test by the Quinckarini method shows anhidrosis over the median nerve distribution. Note the little pin points of sweat across the crease in the middle of the palm, and at the interdigital space of the index and middle finger demonstrating the overlap of the ulnar and radial nerves onto the median area. The black uninterrupted line demonstrates cutaneous anaesthesia; the large black dots cutaneous analgesia to superficial pin pricks; and the crossed analgesia to deep cutaneous pin pricks. Note: this case has an unusually large overlap of pain fibres from the radial nerve onto the median distribution in the ulnar aspect of the index finger.

FIG. 4 (b)—Recovery of sweating and sensibility eight months after nerve suture. The diagram demonstrates the recovery of sweating and sensibility both by increased overlap from the ulnar and radial nerves by true regeneration from the sutured median nerve.

creasing area of altered dye indicates the increase in the number of reactivated sweat glands and is therefore a good sign. A non-sweating—i.e. denervated—area may apparently shrink to some extent through overlap from adjacent nerves and allowance should be made for this tendency.

Types and Prognosis of Peripheral Nerve Lesions

The prognosis in a peripheral nerve injury depends upon the cause of the paralysis.

When a nerve is injured by slight contusion or traction, with temporary loss of conduction but without degeneration of fibres the state is known as *neurapraxia*¹. This condition clears up spontaneously and completely in a matter of days or at the most in 8 to 10 weeks. Nerve conduction below the lesion and the reactions of the muscles remain normal.

When a nerve is injured by crushing or compression without severance of its supporting tissues the axons only degenerate. This state is known as *axonotmesis*¹. Provided that the end organs and joints are kept in good condition a good functional result can be expected with the minimum of delay because the axons can return to their original end-organs, by tracking down their own Schwann tubes. The time of recovery depends amongst other things on the rate of growth of the axons and the level of the injury.

When a nerve is completely severed or densely scarred the state is known as *neurotmesis*¹; at the level of injury axons and supporting tissues are disrupted. Without surgical intervention useful recovery does not occur and even after successful sutures recovery will be imperfect since there is inevitable confusion at the site of the scar and the axons do not therefore always return down their original Schwann tubes e.g. motor and sensory fibres become crossed and arrive at the wrong end-organs. Moreover some fibres may never reach end-organs at all as they are obstructed by the scar tissues at the suture.

The result of this confusion is clearly demonstrated in lesions of the ulnar nerve. After suture independent lateral movements of the fingers are either impossible or if they are accomplished close inspection will reveal small flickers of contraction on the surface of the remaining interosseous spaces and the hypothenar eminence. In most normal persons such contractions are not found. Close inspection of a limb after suture of any motor nerve will show the same behaviour of the muscles when independent action is attempted.

Treatment of Peripheral Nerve Lesions

All types of lesions call for radically the same physiotherapy to prevent joint stiffness and oedema.

¹ Seddon, H. J., *B.M.J.*, 194, p. 327.

The first essential is that the limb should be *splinted in relaxation*. The splint should be removed several times daily so as to prevent joint stiffness.

The second essential is *daily massage*. This is particularly necessary to maintain the circulation and assist in controlling oedema. If necessary oedema should also be treated by postural drainage. Thirdly a full range of *passive movements* should be given at least twice daily.

Where there is a degenerative nerve lesion electrotherapy must be considered especially for paralysis of small muscles of the hand.

While R.D. is present each muscle should be treated by interrupted galvanic stimuli faradism being ineffective. E C S Jackson and Professor H J Seddon at the Wingfield Morris Peripheral Nerve Centre consider that each individual muscle should receive 90 stimuli causing perceptible joint movement at least once daily and twice if possible. The best technique is to give 30 contractions a minute 1 minute to each muscle in rotation and then repeat the process twice giving 90 contractions in all at the same treatment. Improvements in stimulator design are being investigated.

Electrotherapy is continued until the muscles can contract voluntarily against gravity and when practicable may be continued for longer periods. Where recovery is poor treatment is continued until about 6 months have passed with no further progress or increase of voluntary power. The muscle fibres which are innervated and active will be exercised with use but atrophy will continue in totally denervated fibres and those which cannot yet contract voluntarily. Galvanism is therefore used for the sake of these fibres.

When the nerve injury is associated with a wound or fracture a window should be cut in the plaster whenever practicable to allow galvanic stimulation of denervated muscles.

In ulnar nerve palsy where the hand has to be included in the plaster a window can often be cut on the dorsum of the hand to allow stimulation of the interossei. After suture of the nerve the limb is encased in plaster. When the median, ulnar or radial nerve has been sutured the elbow is placed in a degree of flexion depending upon the amount of nerve removed before two healthy ends can be brought together. After 3 weeks the plaster is changed, and then by means of a turn

buckle the elbow is extended 15 degrees each week. The plaster is retained on an average for 6 weeks.

Where a turnhuckle is included a window over the forearm would weaken the plaster too much and so the muscles cannot be treated. The hand however can always be treated even if the wrist has to be included in the plaster.

After suture of the sciatic nerve a hip spica is applied with the knee flexed as much as is necessary to allow the nerve ends to be brought together. The spica is changed after 3 weeks and a turnhuckle is inserted. The average time for which the plaster is retained is 10 weeks. Ideally galvanic stimulation should be applied through the window in the plaster as soon as the patient has recovered from the disturbance after operation, but oedema often makes this impracticable.

After the plaster has been removed treatment is given as for axonotmesis (just described).

Returning muscle movement should from its very first signs be carefully re-educated first by the help of gravity then without gravity and finally against gravity. Eccentric muscle work should be attempted first and both concentric and eccentric work given as power returns. It is essential to avoid over tiring the muscle particularly in the early stages.

General Treatment

Patients with nerve lesions must be treated carefully and sympathetically. The psychological factors are especially important. Results are inevitably slow and unless counter measures are taken the patient becomes discouraged and despondent. His day should be planned so that he is fully occupied and he should be encouraged to carry out constructive work with the affected limb. Remedial and diversional occupational therapy plays an important part in the treatment of these patients and in addition physical exercises should be given to maintain their general physique.

ANTERIOR POLIOMYELITIS

This disease also known as infantile paralysis is caused by a virus with a general tendency to choose as its point of attack that part of the spinal cord in which lie the nerve cells that

govern voluntary muscular movement. It does not however always choose these sites and may attack other areas of the cord and parts of the brain.

The site of attack determines the nature of the resulting paralysis. The bulbar, cortical and ataxic types are rare and little affected by physical methods. The physiotherapist is therefore concerned almost entirely with the spinal and abortive types.

The *spinal* type which is ordinary anterior poliomyelitis originates in the anterior horn cells of the cord and is a flaccid paralysis. As it is a lower motor neurone lesion physiotherapy may have great value in its treatment.

The *abortive* type may originate at various points in the brain or cord. The paralysis is transient and the recovery rate is high. Physiotherapy has considerable value especially in convalescence and re-education. This may be a distinct disease from ordinary anterior poliomyelitis but its treatment is in no way different.

Active Stage

Physiotherapy has a wider field in the flaccid paralysis resulting from anterior poliomyelitis than in cases where muscles are deprived of their motor nerve supply through injury.

When employed early it tends to diminish the extent of the disease in its active stage. Also as the sheaths of the axis cylinders are not interrupted in their run from cord to muscle every lower motor neurone that recovers and pushes out its axis cylinder can reach the original muscle area provided that good physiotherapy has maintained the condition of the whole system from cord to muscle end plate.

In the acute stage rest complete and prolonged is the present key note of treatment. Radiant-heat properly applied will often relieve pain and spasm just as hot baths will in milder cases. Paralysed or weakened muscles must be relieved of all tension and precautions taken against overstretching.

Short wave treatment is better both on physical and practical grounds than radiant-heat or infra red rays. The human body black or white acts as a 97 per cent perfect black body to radiant and infra red rays—i.e. in the whole thickness of the skin it absorbs without reflecting or transmitting 97 per cent of all rays from the luminous to the far

infra red. Thus these rays are converted in the skin to heat which is in its turn conveyed by conduction or convection to the deeper layers. Clearly therefore therapeutic heat can never reach the actual site of the infection in its original form but only by convection and conduction after conversion of the radiant energy. Short wave currents on the other hand pass almost unchanged through the body and a sensible percentage of the oscillations reach the deeper structures before they are converted into heat. By appropriate technique therefore short wave concentrations can be brought to bear on the parts of the cord which are actually the seat of infection.

Short wave therapy should be so used in the early stages of the disease. By this means the inflamed area of the cord can be reached almost as effectively as if it were a boil on the skin or an infected antrum—two conditions especially suitable for short wave therapy. Particular care should be taken that the surface marking for the anterior horn cells in the spinal cord corresponding to the nerves that are affected lies under the active pad. The other pad should be placed opposite and not on the affected limb. Treatments should, if possible be given 3 times in the 24 hours and should begin on the day the diagnosis is made.

On clinical grounds too this current is the method of choice as it can be given without any essential disturbance of the patient.

Convalescent Stage

The principles of treatment during this stage are prevention of the development of deformity, maintenance of the condition of the affected areas and restoration of function.

Prevention of Deformity

Malposition in its early stages is usually due to muscular weakness. If it is allowed to proceed weakened muscles are lengthened and the opposing group are shortened and so it will gradually develop into a permanent deformity.

Splinting—Weakened and paralysed muscles should be splinted not only to ensure rest but also to prevent their over stretching by the action of the opposing normal groups. The splinting should be light and so constructed that it will not interfere unduly with the normal circulation and be readily

removable for treatment. For this reason plaster or perspex splints are the most suitable and for the limbs back splints are better than complete casing. In the early stages the splints will need to be worn most of the time but as muscle function returns they may be left off for some hours during the day and finally worn only at night.

Maintenance of Condition and Restoration of Function

As damaged axis cylinders can go on recovering for at least two years if not longer the maintenance of condition is most important.

In peripheral nerve injury degenerative processes in muscles cut off from their nerve supply are retarded if the muscles are subjected to intermittent galvanic stimuli. The same technique is also largely applicable to convalescent anterior poliomyelitis cases.

Suspension therapy is by far the best method of assisting the rehabilitation of paralysed muscles. (See page 130.)

SPASTIC PALMIES

These conditions which are found after lesions of the upper motor neurone especially hemiplegia do not show either abnormal electrical reactions or gross muscle wasting. The condition of the affected muscles is hypertonic and in due course groups become more and more spastic and contracted. In the arm for instance fingers wrists and elbows are all in full flexion and the arm itself adducted across the body.

Here therefore is a completely different pathological condition from that of a lower motor neurone injury. The value of physical therapy is greatly restricted because the lesion is not in an accessible situation nor of a kind that makes it amenable to repair. The problem before the physiotherapist is to secure the greatest measure of palliative comfort and to assist in staving off as long as possible the distressing and ungainly effects of spastic contraction. The only electrical current that has proved of any real clinical value is the surging sinusoidal current given where possible in a full-sized bath. It acts by reproducing artificially the normal train of unco-ordinated impulses that are always passing down to muscles, and so helping

to produce something akin to normal metabolism. It should be given at least 3 times a week and continued for many months. It need not be so strong that unaffected muscles make painful contractions. Barely visible movement only is required, for 15 minutes with the electrodes so placed that the current passes longitudinally down the paralysed muscles.

For these cases under water massage is one of the most effective methods known. The loss of weight of the affected limb in the water and the warmth make much easier the passive movements which prevent contractions.

Massage, passive movements and the maintenance of joint mobility can do much to mitigate the misery and discomfort of these cold, stiff and painful limbs.

SCIATICA

Sciatica is not a disease. Every physiotherapist must keep this fact always steadfastly in mind. The word merely points to the area over which certain widely varying symptoms seem to be distributed—the area covered by the sciatic nerve.

The physiotherapist should next remember that in the great majority of cases called sciatica pain cannot be produced by pressure in the line of the sciatic nerve anywhere from the buttock fold to the ankle and that when this region is tender to palpation the case requires totally different treatment. The sciatic nerve is so situated anatomically that it is peculiarly susceptible to pressure or traction from the moment it leaves the spinal cord until it enters the posterior partition of the thigh. A prolapsed or partially prolapsed intervertebral disc can irritate the roots of this great nerve as it emerges from the spinal canal, so also can tumours, aneurysms, infections and other factors. The differential diagnosis of sciatica is not the business of the physiotherapist, but unless this diagnosis is accurately made she may be instructed to treat a case which can of its very nature only be made worse by physiotherapy.

The physiotherapist is therefore chiefly concerned with

- (1) Subacute and chronic sciaticas associated with rheumatism and arthritis
- (2) True sciatic neuritis
- (3) Sciaticas associated with prolapse of the intervertebral disc
- (4) Sciaticas in which physiotherapy is palliative only

1 Sciaticas Associated with Rheumatism and Arthritis

Gouty Sciatica

Recurrent attacks of sciatica like attacks of lumbago are common in persons with a raised blood uric acid and in those who improve under a regime directed against gout. It is essential to increase the activity of the skin with mild pyroxial treatment whether by infra red rays radiant-heat heat baths Wilde's baths or any of the similar methods used at spas. The important aim is to secure a rise of at least 2° or 3° F and profuse sweating during each treatment. Physiotherapy of this kind is however of little value unless habits diet and exercise are dealt with at the same time.

The Sciaticas of Osteo-arthritis of Hip or Spine

Pain in the sciatic region is all too commonly attributed to the most minor radiological changes found in the lumbar spine sacro iliac joint or hip-joint. This is unfortunate. The physiotherapist must constantly remember that a patient can have extensive radiological changes in these areas and yet be completely free from all past history or present signs and symptoms of sciatica. It is probably correct to say that some chronic form of infection is responsible for the bulk of osteoarthritis in this area. If so then the soft tissues in the neighbourhood are also the seat of chronic infective changes. Obviously muscles lymphatics nerves and their supporting fibrous tissues are a more hopeful target for any treatment than bony spurs that have long since become calcified. A patient should never be relegated to the grin and bear it group on account of bony spurs nor submitted to operation until the practitioner is fully satisfied that all methods of physical therapy have been fully tried.

Regarding this group as basically of the infective type the local treatment of choice is the Kromayer lamp with rod applicators of cm diameter and deep pressure at suitably selected sites.

These sites are three. The first is situated just opposite the 12th rib on the outer side of the erector spinae. The second is in the gap between the transverse process of the 5th lumbar vertebra and the posterior superior spine of the ilium—that is over the ilio-

lumbar ligament. The third is best determined with the patient either in side lying or forward lying. It is approximately a square with one side resting on the great trochanter the posterior side in front of the line of the sciatic nerve the upper side well below the iliac crest and the fourth side roughly in line with the anterior border of the great trochanter. This area approaches but does not cover any part of the sciatic nerve trunk. It does however include a number of the nine hursæ situated round the hip-joint (Fig. 5).

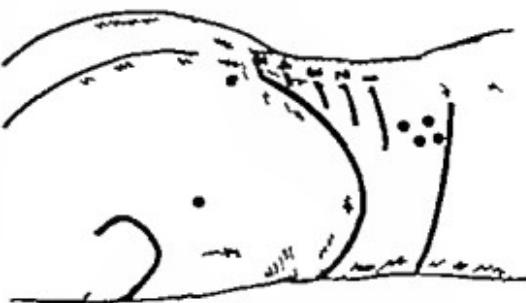


FIG. 5.—Sites for the application of Kromayer rods as described in the text.

All points producing pain or the feeling of a bruise when pressed upon should be treated in rotation. At the first treatment 10 areas of application should each be given an erythema multiplied by 2. Treatments can be given twice a week. If the patient is sensitive to light or the dose is more than twice the erythema dose the treated areas should be covered immediately with elastoplast. The part under treatment must be made as bloodless as possible by pressure. Probably the short-wave infra red region ($\text{\AAngstr\"om } 9\text{--}11\text{,000}$) which is not absorbed by the water jacket and penetrates tissue deeper than any ultra violet light is the band which produces the response to therapy. If this technique does not produce any improvement after 3 treatments further applications are valueless. It acts quickly or not at all. It should never be used during an acute phase of any peripheral nerve pain.

If the Kromayer apparatus is not available cases in this group respond best to changes of treatment the essence being to increase the blood supply and metabolism in the two areas already defined for Kromayer applications—viz. the lumbar region right up to the origin of quadratus lumborum and psoas, and the region of the hursæ of the hip joints. The changes can be rung on short wave histamine ionisation infra red rays or radiant heat with methyl salicylate liniment and mud packs.

Sciatica with other Rheumatic Manifestations

One very common and large group of cases gives a history of subacute or even transient sciatic pains as part of other

symptoms that may be in back, abdomen neck arms or the other leg. These cases are practically without exception basically toxic from some chronic focus of absorption the commoner foci being situated in the nose throat sinuses and teeth or large bowel.

Chronic lumbago or low back pain with left-sided sciatica may be due to diverticulosis or diverticulitis. The removal of the focus of infection is here the prime factor in treatment. Obviously if while the focus is still active the physiotherapist increases the blood supply to the part by such treatment as radiant-heat and massage there is a definite probability that she will make the condition worse. While it is still undesirable to use physiotherapy during or before the main focus is determined treatment that decongests and tends to neutralise or remove toxins without increasing the general blood supply is justified.

Two choices exist the area of pain can be treated with 3 times the full erythema dose of ultra violet light, immediately covered and supported by strapping which extends over a wider area and then left for 7 to 14 days or the anode of the direct current with an antitoxic positive ion such as zinc or silver can be applied, the negative pad being placed over the nearest glands to which the painful area drains. The current should be kept low—2 to 5 m.a—and may be given daily for not more than 15 to 20 minutes.

2 True Sciatic Neuritis

In the true sciatic neuritis the nerve trunk in the thigh is itself tender to palpation. These cases are almost certainly all toxic in origin. For the purposes of physical therapy three types can be recognised

- (a) The acute
- (b) The convalescent.
- (c) The resistant or sluggish.

(a) *The Acute Type*

The centre point and keynote of all treatment for the really acute cases of sciatic neuritis is rest and avoidance of all physiotherapy with the possible exception of massage to the arms and gentle breathing exercises to maintain the patient's condition under rigorous immobilisation. The suggestion by the patient's friends to have treatment because it did some-

one else a sciatica so much good should be firmly resisted by every physiotherapist unless and until detailed specific instructions are given by the practitioner

(b) *The Convalescent Type*

When the acute stage has passed, the physiotherapist has invaluable work to perform. In acute cases wasting is often rapid and extensive and not infrequently muscles supplied by the sciatic nerve show reaction of degeneration. For these muscles light plaster splints are required. At present interrupted galvanic contractions are among the chief therapeutic measures. 30 contractions a minute for 3 minutes twice daily is the recommended dose.

A technique that gives satisfactory results is first to get the leg thoroughly warm. This can be done by short-wave one pad at the sole of the foot and the other opposite the sacro iliac joint with the patient in half lying. The current strength and duration should be sufficient to make the patient aware at the first treatment of warmth nearly up to the knee without aching at the ankle. As soon as this is secured, every muscle in the wasted limb should be given about 10 to 20 contractions using the faradic current for those muscles that will respond galvanic interruptions for those that will not. Then repeat the short-wave treatment for 10 minutes where a plaster splint is in use it can be re-applied before this second period of short-wave treatment.

Progress is made by increasing the number of contractions at each treatment and eventually reducing the short-wave dose being guided by the retention of warmth after treatment and the regeneration of the lost muscle bulk. Where short-wave is not available it is better to warm the leg by a simple hot bath or the use of a hair-drier than to employ either radiant-heat or infra red rays both of which may do further damage.

Where a suspension apparatus with springs is available the affected limb should be encased in a long theatre stocking and treated by this method (page 128). When the leg is so covered a radiant heat lamp may properly be used to give general warmth as the theatre stocking will convert any direct short infra red rays into longer ones to which the body metabolism is better adjusted. Suspension therapy is of the greatest importance in the treatment of all sciaticas. It should be

introduced as soon as the acute stage has subsided, and given daily by a physiotherapist skilled in its use

(o) *The Resistant or Sluggish Type*

Cases of true sciatic trunk neuritis are apt to cease improving and to suffer for long periods from pain on certain movements or in particular positions. Sometimes pain may start when the patient is trying to get to sleep in bed.

The re-formation of the muscle mass goes to a certain point and stops and footdrop is cured only incompletely and unsatisfactorily.

Physiotherapy in these cases often seems to be doing no good whatever and therefore tends to be dropped. This is the time not to drop physical treatment but to intensify and vary it.

After short-wave suspension therapy interrupted galvanism and faradism have been fully used one of the following techniques may start new progress towards recovery and is always worth trying. In some cases there is a small localised patch of tenderness in the line of the sciatic nerve about half way down the thigh.

This area should be given 2 or 3 treatments of intensive iodine and sodium salicylate ionisation with a negative pad about 6 ins by 2 ins the indifferent electrode, the positive should be a large pad 9 ins by 4 ins placed on the front of the thigh opposite the negative. The patient should be treated in forward lying with the feet slightly raised on a pillow the pad over the sciatic nerve should be kept in place by a large sand bag. A dose of 200 to 250 milliampère minutes should be aimed at with 2 to 3 days interval between treatments. If this fails to relieve the negative pad should be placed just below the tender area and the positive this time with histamine over the sciatic notch. With this technique long low intensity infiltration is used such as 20 to 30 minutes at 5 to 7 m.a.

Definite constitutional signs are an indication to cease treatment.

If this intensive ionisation treatment shows some indication of usefulness but is not giving full relief surging sinusoidal current should be superposed. If these fail counter irritant doses from the Kromayer lamp in the line of the sciatic nerve should be tried. The bare face should be used and an erythema multiplied by 4 or 5 given. The sites of application should

afterwards be covered with elastoplast. Epidural and other injections as well as nerve-stretchings under anaesthesia are in the province of the medical practitioner but may be required in fully resistant cases.

3 Sciatica Associated with Prolapse of the Intervertebral Disc

The physiotherapist has, fortunately for her no responsibility for the diagnosis of a case of prolapsed intervertebral disc. It is however essential that she should realise certain simple physical facts of this seriously disabling condition because she can then appreciate the purpose of rehabilitation methods.

The great majority of prolapsed discs begin with a history of injury. This injury may be clear, definite and severe or it may be a summation of minor strains acting on tissues already debilitated by a toxic absorption.

A disc prolapses by herniating towards the thecal canal at those parts of its circumference that lie between the outer borders of the anterior longitudinal ligament and the line of the lamina. When it does this it comes into immediate and close relation with the corresponding intervertebral foramen. A very small protrusion can exert pressure on the nerve roots passing to this foramen (Fig. 6 Plate III).

Clearly therefore there can only be two basic lines of curative treatment.

- (a) Immobilisation
- (b) Surgical removal of the prolapsed disc

(a) Immobilisation

To give any chance of effective repair immobilisation must be preceded by removal of all definite potentially debilitating septic foci and then the immobilisation must be long and absolute. It may run into a number of weeks and even require a plaster bed. During this period the only opening for physiotherapy is to maintain the condition of the breathing mechanism and the upper limbs. During the period of immobilisation the structures passing out of the intervertebral foramen may possibly adjust themselves to any obstruction at the outlet. Towards the end of the period the physiotherapist has a vital part to play if relapse is to be avoided. The muscles of the leg

must be re-educated without throwing strain on the recovering sciatic nerve. While the patient is still lying on his back the following exercises may be gradually introduced.

Lying toe clawing foot and ankle movements

Lying static quadriceps contractions combined with dorsiflexion and inversion of the foot

Lying abdominal contractions.

Lying gluteal contractions.

Lying knee bending upward retaining the foot on the bed progresses to

Lying knee bending upward followed by knee extension and straight leg lowering

Lying knee updrawing and down pressing progresses to leg up drawing and outdrawing

Lying hip abduction and adduction.

Lying hip internal and external rotation

Lying hip circumduction.

Lying leg lifting (the gymnast should not try to stretch the sciatic nerve by dorsiflexion of the foot)

The last exercise should be cautiously introduced. Any exacerbation of pain after the movement definitely indicates that the range of movement has been extended too far. The muscle tone of the unaffected leg must also be maintained but care must be taken that strain is not thrown upon the affected leg when giving movements such as hip flexion and straight leg lifting.

The patient is now ready to enter the stage that leads to re-training in walking. The best position for this is half lying with if the bed allows it the legs dependent over the end of the bed. In this position it is far easier to grade exercises with the least possible strain on the muscles and from it to pass to supported walking. As soon as supported walking has passed safely without return of sciatic discomfort to free walking the patient should be safe to join a small class for exercises.

If a suspension therapy apparatus that can be brought to the patient a bed is available it should be employed from the stage when rigid immobilisation is nearing completion (page 128 page 120 Ex (ii) treat both legs, page 125 Ex (i))

(b) After Removal of Prolapsed Disc

Here the objectives are somewhat different from those of immobilisation. They are to prevent adhesions in the operation

are to avoid over formation and contraction of fibrous tissue and to secure that the cut muscles repair so that they can function painlessly and without restriction. Rehabilitation can be started the day after operation.

The patient lies on his side for the first 3 days. He is then allowed to lie on his back and is encouraged to move about as much as possible. He is allowed to get up at about the 15th day.

Post-operative Scheme of Exercises

Ist to 3rd day

Side lying localized breathing exercises.

4th day

- 1 Lying toe clawing foot and ankle movements combined with finger and wrist movements.

- 2 Lying shoulder rolling with breathing

5th to 8th day

- 3 Lying quadriceps and hamstring contractions.

- 4 Lying abdominal contractions on exhalation.

9th to 12th day

- 5 Lying static contractions of back muscles and gluteal contractions.

- 6 Lying alternate knee bending upward retaining the foot on the bed

13th day

- 7 Lying double arm parting and closing with breathing

- 8 Lying elevation of thigh and anal impression.

11th to 12th day

- 1 Lie in prone static state

- 2 Lie alternate knee updrawing and down pressing

- 3 Lie alternate knee flexion and impression

13th to 15th day

- 1 Exercise substitute

- 2 Lie side back stretching

- 3 Exercise substitute

- 4 Thighs alternate leg lifting backward

16th to 18th day

- 1 Lie in side of the bed

- 2 Lie in lateral position contracting gluteal

19th to 21st day

- 1 Lie in lateral elevation in lateral position

- 2 Exercise substitute

- 3 Lie in lateral position

For exercise 9 substitute

Half yard grasp standing alternate leg swinging backwards and forwards.

After the 18th day the patient should be fit to progress to class activity

If a scoliosis still persists after operation special correcting exercises should not be given but emphasis should be laid on double-sided mobility exercises and re-education in walking

Electrotherapy can be employed to some advantage during post-operative convalescence Ultra violet light may be used for its tonic effect and short-wave current to increase the blood supply The keynote of success is however muscle rehabilitation by the voluntary work of the patient Re-education in walking after an operation for prolapsed disc is of course—especially for patients who have limped or bent to one side for long periods—of first importance

4 Sciaticas in which Physiotherapy is Palliative only

These are the sciatica associated with tumours aneurysms and allied conditions It is entirely legitimate to give these patients soothing or palliative treatment Not only does such treatment have a definite psychological value by suggesting that something is being done but it can also give material help in aiding the removal of toxic products Here is a field for radiant-heat or infra red rays and massage In the sciatic area as elsewhere short-wave current should never be employed in any case where a new growth is known to exist or where pus is shut in It is however not contra indicated in aneurysm The pain from an aneurysm pressing on the roots of the sciatic nerve can sometimes be definitely and satisfactorily relieved by short-wave current through the area of pressure

CHAPTER 3

IN CHEST CONDITIONS

MECHANISM OF RESPIRATORY MOVEMENT

PHYSIOTHERAPY has a wide and useful field in any chest conditions

A short consideration of the mechanism of respiratory movements will help the physiotherapist to a better understanding that sound anatomical principles have formed the basis of the most recent work in reconditioning patients after chest operations or illness. No better authority on this can be quoted than Sir Arthur Keith. He describes the average normal respiratory movements of the thorax as a sequence of events occurring in the following order.

At the beginning of inspiration the 1st rib and manubrium sterni are more or less fixed and act as a fulcrum for the 2nd to 5th or upper series to move upon. The antero-posterior diameter of that portion corresponding to the upper series increases first and is followed by an increase of the lateral diameter of the thorax. Immediately after the first part of this double movement and before the second has really commenced the 6th to 10th ribs begin their movement but this time the lateral expansion of the thorax precedes the antero-posterior enlargement. Finally as respiration becomes deeper the 1st rib and manubrium become slightly drawn upwards.

Two points in particular must be here emphasised. First the sequence of rib movements is largely individual and may and does vary somewhat widely in the normal subject. Secondly the expiratory muscles are in use during inspiration and the inspiratory during expiration—that is respiration is a finely balanced muscular act. The movement of the ribs is therefore an undulatory act consisting of two waves partially out of phase with each other. It should also not be forgotten that at any rate in deeper respiration as pointed out by Arbuthnot Lane Hall, Daly and others—there is a definite extension of the dorsal spine which appears also to have an undulatory character from below upwards. When respiration is less deep the iliocostalis and longissimus dorsi portions of the

erector spinae continue to take an active part in both inspiration and expiration as by acting statically or in balance they can provide a holding point for the intercostals to act upon. In this state the axis of the hinge movement of the ribs is between the angle and the head the rib at the costo-transverse joint moving down during inspiration.

It seems probable that in the act of inspiration and expiration it is necessary also to take into account Sherrington's work upon the two distinctive characteristics of skeletal muscles—namely static and kinetic power. By realising the effect of these properties it becomes easier to understand how one set of ribs may obtain from another the necessary fixed points for their own movement and then themselves become fixed.

Lung Movements

During the downward plunge of the diaphragm the lungs move down and this movement includes a downward movement of their roots. A movement of this kind naturally puts a considerable pull on the whole tissue in a longitudinal direction and is particularly effective in expanding those infundibula enclosed in a cone whose base is the diaphragm and whose apex is the apex of the lung. As Keith and Flack point out the lung is of varying extensibility and owing to this property the organ expands in the manner of a Japanese fan. It is also a delicate structure and without an undulatory arrangement the infundibula would be easily impaired. Another zone of expansion coincides with that part of the thorax which is the first to initiate rib movement and is chiefly concerned with the expansion of the upper lobe of the lungs.

Summary

To sum up The anatomical movements concerned in inspiration are

- (1) A flattening of the cupola of the diaphragm followed by a downward and forward movement of the diaphragm as a whole
- (2) during the first part of this movement when the lower ribs are required to be more or less immobile the beginning of movement in the upper set of ribs takes place which when well initiated is followed by (3) the movement of the lower set of ribs (this last being a necessary adjunct if the tone of the costo-sternal portion of the diaphragm is to be maintained as the central tendon descends)

During both expiration and inspiration the spinal muscles play an active part working upon what we may call the posterior hinge of the ribs.

A. PHYSIOTHERAPY IN CHEST CONDITIONS

Aims of Treatment

Re-expansion of the lungs and increased vital capacity by breathing exercises is the primary aim of treatment in all chest conditions with two exceptions—namely tuberculosis and lung abscess.

The following aims of treatment are common to all chest conditions:

- 1 To endeavour to prevent deformities and correct any already formed.
- 2 To increase mobility of the thoracic cage.
- 3 To aid general fitness.
- 4 To encourage in the patient a hopeful outlook, and the will to recovery by his own effort and activity.

The importance of early treatment especially in surgical cases cannot be overstressed as this tends to prevent adhesions thickening of the pleura stiff shoulders and deformities such as scoliosis.

Breathing

Breathing may be divided into

- (i) Localised breathing
- (ii) Diaphragmatic breathing
- (iii) General breathing

(i) *Localised breathing*—The technique employed in localised breathing necessitates gentle resistance by the operator's hands to the patient's movements. There are five main positions for placing the hands:

- 1 Lower ribs
- 2 Under the axillæ.
- 3 Apex
- 4 Diaphragm
- 5 Posteriorly (lower lobes lie mostly to the back)

In teaching breathing relaxation is most important. The patient should lie comfortably head and shoulder supported and knees slightly flexed.

Strained breathing is discouraged and the patient's attention is directed to the gentle swelling out of the lung against his own or the operator's hand. The resistance should be given through the heel of the hand. This method of breathing demands the full attention of operator and patient. Note In unilateral cases e.g. an empyema, the patient is taught to concentrate on the affected side and on the most flattened or collapsed part. To do this the hand is removed from the sound side and all the attention concentrated on the affected side.

(ii) *Diaphragmatic breathing*—Proper use of the diaphragm in relation to the expansion of the chest is as has been shown by Sir Arthur Keith all too seldom achieved. It is a common occurrence even in reasonably healthy people to find the diaphragm making little or no movement during inspiration or even rising slightly. Fortunately re-education of this muscle to co-ordinate with chest expansion is not difficult for the skilled technician. The technique employed is as follows:

The fingers are placed lightly on each side of the upper abdomen, just below the costal arch. On inspiration the upper abdomen should swell gently upwards and outwards against the fingers.

On expiration, the upper abdomen should sink gently down under the fingers as if it were being tucked in under the ribs.

In cases where dyspnoea is present the patient can be helped by inducing him to change over as far as possible to quick diaphragmatic breathing.

Types of Cases

The cases most commonly presented for treatment are

- 1 Empyema
- 2 Penetrating chest wounds.
- 3 Crush injuries
- 4 Bronchiectasis
- 5 Lobectomy and Pneumonectomy
- 6 Thoracoplasty

SPECIAL NOTE The treatment of a lung abscess by breathing exercises is not advisable as there is a risk of spreading

the infection. Where complete drainage has taken place exercises may be given.

In a case of lung abscess associated with empyema breathing exercises are given gently because the risk of withholding exercises from an empyema case is greater than giving them to a lung abscess. Progression is slower than in a case of empyema only.

I Empyema

Empyema whether acute or chronic or after pneumonia influenza or as a complication of septicaemia presents the problem to the physiotherapist of inducing the lung to expand to the chest wall and obliteration of the cavity.

Physiotherapy should start the day after rib resection has been carried out and drainage secured. At the first treatment it is essential to explain simply to the patient the nature of his condition and the importance of breathing exercises in hastening recovery. A very simple diagram showing the necessity of bringing the lung out to the chest wall is helpful in this preliminary instruction.

The physiotherapist should from the beginning encourage the patient to move as freely as possible in bed. He should be made to realise the importance of activity in re-expansion of the lung. The correction of any tendency to bad posture at all treatments such as drooping towards the affected side cannot be over-stressed.

These preliminaries being secured the first actual treatment by breathing begins with gentle breathing exercises. First diaphragmatic breathing is encouraged. Secondly attention is concentrated on the sound side to accustom the patient to the movement. Breathing on the affected side is then introduced by directing the patient's attention to the most collapsed or flattened part. This focusing of attention is important throughout the treatment.

Movement of the arm on the affected side should then be secured. If the patient can be persuaded to do this himself so much the better if not supported active movement but with the minimum of support should be given.

The patient should be given a limited number of exercises to perform by himself between treatments especially diaphragmatic breathing. Times should be set to practise these

exercises for not more than 5 minutes in every 2 hours Subsequent treatments consist of gradual increase in the range of the breathing and of mobility exercises and the time spent on them

From 4th to 5th Day —In 4 or 5 days the patient can usually sit up and carry out for himself mobility exercises such as

Shoulder rolling

Head movements

Gentle side-bending away from the affected side.

Arms upward stretched hands clasped gentle spine-stretching

From 7th to 10th Day —In 7 to 10 days if the temperature is normal the patient is assisted to walk about the ward and is encouraged to go out into the fresh air as part of the definite time spent on him by the physiotherapist

From 10th to 14th Day —In 10 to 14 days the patient should be ready to join a Postural Exercise Class in the hospital department

Class Exercises for Empyema Cases

The following tables of mobility and postural exercises have proved themselves satisfactory when patients are physically fit enough to join in class work. If music is available it is particularly useful for helping these patients to regain a sense of rhythm in their chest movements. The following tables of exercises are adapted to the rhythm of the Gold and Silver Waltz (Lehar) H.M.V. 12 inch record. Other records can of course be found that are similarly suitable

Table I

- 1 Bend sitting (trunk slightly forward bent) double shoulder rolling
- 2 Sitting head bending forward and backward.
- 3 Sitting double arm swinging forward and upward and downward then sideways and upward and downward Repeat
- 4 Sitting knuckles on ribs, elbows held in a horizontal line alternate sideways movement of chest against pressure of knuckles (slight waist movement)
- 5 Across bend sitting double arm flinging
- 6 Hands support on knees sitting alternate trunk rotation with arm upstretching (palm facing forward) 4 times to the right 4 times to the left
- 7 Relax stoop stride sitting trunk raising vertebra by vertebra

Table II

- 1 Yard stride standing alternate toe touching in 4 movements (i) swing right (ii) touch left toes with right hand (iii) raise still facing sideways (iv) swing to the front and vice versa
- 2 Standing hands clasped behind back shoulders pulled well back and downwards alternate leg circling (forward, sideways and together)
- 3 Stride standing alternate arm upstretching
- 4 Stride standing knuckles on ribs stretching away from the affected side in 3 small movements
- 5 Stretch stride standing hands clasped, spine stretching
- 6 Stretch stride standing hands clasped side bending away from the affected side
- 7 Stride standing punching to alternate sides.
- 8 Neck rest standing alternate knee slowly updrawing and lowering
- 9 Stride standing double arm circling

The importance of activity on the part of the patient cannot be over-stressed. This is especially so in cases of chronic empyema where drainage is prolonged.

Indian-club swinging, fencing and games such as badminton and football should be encouraged.

Many patients should be encouraged to go back to active occupation before the drainage tube has been removed.

2 Penetrating Chest Wounds

Penetrating chest wounds give rise to haemothorax and haemopneumothorax which require repeated aspiration to withdraw the fluid. Breathing exercises to hasten re-expansion of the lung are initiated as soon as possible. The technique employed is the same as for empyema, the patient's attention being directed to the collapsed area. If the effusion becomes infected a pyopneumothorax results. This is drained and is treated on similar lines to an empyema.

3 Crush Injuries

As these injuries involve fracture of ribs early treatment is contra indicated.

4 Bronchiectasis

Bilateral Bronchiectasis

These cases can to a certain extent be helped by postural drainage and exercises.

The aims of treatment in this conditions are

- (i) To increase chest expansion and vital capacity by general breathing exercises.
- (ii) To aid drainage by hacking and clapping and pressure on the affected area whilst the patient is in the correct drainage position
- (iii) To improve posture mobility of the thoracic cage and general fitness by suitable exercises

Methods of Postural Drainage

Drainage of the lung is greatly aided by the positions taken by a patient whereby gravity aids the flow of the purulent

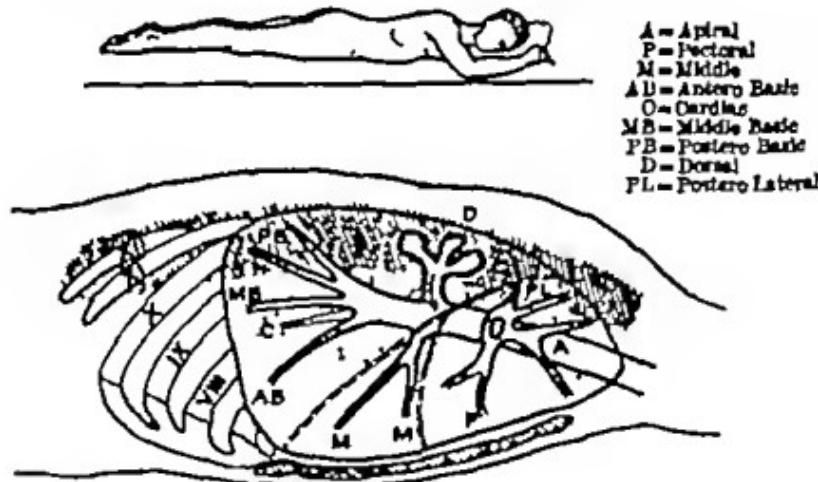


FIG. 7a.—Postural drainage position for lower lobe of lung.

secretion towards the main bronchi. A reflex is set up and the patient coughs and expectorates. They are known as Postural Drainage Positions.

Owing to the action of gravity bronchiectasis of the lower lobe is very common. The drainage position is prone lying with the head turned towards the affected side (Fig. 7a). When the base of the lobe is affected the head and trunk must be inclined downwards (Fig. 7b). This is effected by means of

Patients should take up their correct Postural Drainage Posture for at least 2 or 3 hours 3 times daily and sometimes all night

Unilateral Bronchiectasis

Operative treatment consists of removal of a lobe or lobes—lobectomy or a lung—pneumonectomy

5 Lobectomy and Pneumonectomy

It is impossible to over-stress the value and importance of pre-operative instruction for post-operative treatment. Un hurried time should be spent upon it and the physiotherapist giving the pre-operative instruction should be detailed for the post-operative treatment.

Pre-operative Training for Post-operative Treatment for Lobectomy and Pneumonectomy

The following points should be explained to the patient

- 1 That the remaining lobe or lobes can and will expand to fill the cavity and that it is important to gain full expansion as soon as possible
- 2 That owing to the cutting of the shoulder girdle muscles movement of the arm on the affected side will be weak and stiff for a long time. The patient should then be shown the diaphragmatic thoracic and arm movements that will be carried out the day after operation

In this way the confidence and co-operation of the patient will be gained beforehand

Post-operative treatment for lobectomy and pneumonectomy cases should be started the day after operation provided that the general condition of the patient is satisfactory.

Treatment on the first day should include the following

- 1 Diaphragmatic breathing
- 2 Encouragement of gentle movement of the remaining lobe or lobes.
- 3 Gentle elevation of the arm on the affected side until limited by pain.
- 4 Correction of any tendency to bad posture

To begin with short treatments 2 or 3 times daily are helpful

Day by day gradually increase breathing and arm movement according to the condition of the patient

When the stitches are removed gentle shoulder and shoulder girdle exercises in a sitting position may be given. It is important to encourage the patient to move freely in bed, and to avoid rigid attitudes.

Mobility and breathing exercises are gradually increased until the patient is able to join a class in the department. A straightforward case may be able to do so in a month or 6 weeks.

Sometimes after a lobectomy or pneumonectomy a broncho pleural fistula occurs and the cavity becomes infected causing a residual empyema which retards recovery.

6 Thoracoplasty in Pulmonary Tuberculosis

In this operation ribs are resected in order to mobilise the chest wall so that the lung may collapse the chest wall reforming in the collapsed position. This is done in stages varying from 2 to 3 or 4 according to the size and position of the cavity. The shortest interval between stages is a fortnight.

At the first stage the whole of the first 2 ribs and most of the 3rd are removed. At each succeeding stage varying parts of the ribs are resected this again being determined by the size and position of the cavity.

A complete thoracoplasty involves the resection of 9 or 10 ribs.

At the first stage the scalene muscles are severed from their attachment to the ribs and—unless guarded against—this gives rise to a deformity typical of this condition. In this deformity the head tends to deviate to the sound side (Fig. 8 a-h Plate IV).

The removal of the ribs allows the transverse processes to spread to the limit of the intertransverse ligament thus causing a tendency to scoliosis with the convexity to the affected side. Sometimes a number of transverse processes are removed and in consequence the strong intertransverse ligaments cut. This also greatly increases the tendency to scoliosis.

The incision is a long para-scapular one involving the cutting of shoulder girdle muscles—trapezius, rhomboids, serratus magnus, latissimus dorsi (Fig. 9 Plate V). At each stage the scar or the greater part of it is re incised. It is therefore very

important to give early arm movements and later on shoulder girdle exercises

Sometimes after a two-stage thoracoplasty the inferior angle of the scapula tends to get caught up on the remaining ribs causing a high shoulder. To prevent this a partial scapulectomy is sometimes performed. This interferes with the attachment of the serratus magnus to the inferior angle of the scapula. Full elevation of the arm therefore takes longer and is a little more difficult to obtain.

Pre-operative Treatment of Thoracoplasty

- 1 Aim to gain the confidence and co-operation of the patient for post-operative treatment
- 2 Establish efficient diaphragmatic breathing
- 3 Explain to the patient the tendency to head deviation and the importance of maintaining as good a posture as possible after operation.
- 4 Show the patient the arm movements to be carried out after operation

Post-operative Treatment of Thoracoplasty

This begins 24 hours after operation.

- 1 Encourage diaphragmatic breathing but allow no other type of breathing exercises in the treatment of this condition.
- 2 Secure gentle assisted elevation of arms, without causing pain and thus resistance on the part of the patient. Take care to avoid any tension on stitches
- 3 Correct any tendency to bad posture

Continue gently for a week, until the stitches are removed. Gentle head shoulder and shoulder girdle exercises may now be given in a sitting position.

Complete active elevation of the arm should be obtained in a fortnight after the first stage. Sometimes it takes a little longer after the second stage.

This method of treatment is carried out after each stage.

Exercises should never be vigorous and care must be taken to avoid causing fatigue or dyspnoea. This is especially important where there is bilateral disease.

General Notes

In cases of partial scapulectomy movements to shoulder level only are given for the first week. Full elevation may be

attempted. Full active elevation is not obtained for some weeks.

A swing mirror between uprights which can be wheeled from patient to patient is very useful in helping to correct posture.

Thoracoplasty patients are often confined to bed for a long time and it is a good scheme to give gentle leg and foot exercises.

A thoracoplasty is sometimes performed to close a cavity in a case of chronic empyema. Treatment is the same as for thoracoplasty in tuberculosis except that breathing exercises may be given to the sound side and to any part of the affected side still functioning.

Postural exercises should be continued by the patient under supervision for at least 1 year as it is quite possible for a scoliosis to develop after the patient has been discharged from the surgical centre.

B MEDICAL CONDITIONS

1 Asthma

(i) *Short wave diathermy* given through the mediastinum to the area of the ensiform cartilage. This always deserves a trial in cases of asthma. In about one in five cases it brings considerable relief sometimes for long periods.

Apparatus required

- 1 short wave diathermy apparatus
- 2 large pads, about 6 ins. or 8 ins. square
- 4 pieces of thick felt or gauze
- 2 quite dry towels

If the apparatus employed will not tune fully when pads of the above size are used it is better to use 1 large and 1 small pad.

Method — One of the pads, two felts and a folded dry towel are placed between the shoulder blades with the patient in a half recumbent position. The other pad is placed centrally at the upper limit of the abdomen. 6 minutes treatment only is given at the first application. Later this can be increased to 1 or even 20 minutes according to the patient's response. The reason for the short period of the first treatment is that

some patients are sensitive to this current and react badly in which case further treatments are contra indicated

In favourable cases the treatment for chronic asthmatics should be given not less than twice a week for an initial course of 6 weeks and then after a short interval once a week for another 6 weeks. In acute cases the treatment may be given twice or even 3 times in 24 hours ceasing entirely with the relief of the acute attack.

(ii) *Ultra violet light*—Ultra violet light may be tried especially in cases that have failed to benefit from short-wave diathermy but minimal erythema doses should be given at first as some asthmatic patients are actively photo-sensitive. A clue to the existence of this condition can usually be obtained by the patient's own history. Treatment should begin on the legs only the abdomen being the last part of the body to be exposed to the light. It should be given on alternate days and the exposure times should be increased slowly.

(iii) *Exercises*—Asthmatic patients are often of the nervous highly strung type. Treatment at first should be devoted to teaching relaxation. In the lying position the patient is encouraged to let the whole body go limp beginning with the lower limbs and working upwards to the trunk head and neck.

In asthmatic attacks the extra muscles of respiration come into play and quick gasping inspirations are taken without full expiration. To control this diaphragmatic breathing with full expiration and abdominal contraction is taught. The inspiration is short really a relaxation and there should be no movement of the upper chest.

At first the patient can only do short expirations without gasping and raising the upper chest. With practice and encouragement a long expiration with abdominal contractions can be obtained. This movement should be mastered before other exercises are taught and the patient should be encouraged to practise it if possible before the onset of an attack.

Lateral expansion of the chest is often poor. Hands should be placed on the lower ribs. A long expiration is followed by an inspiration against the resistance of the hands.

Shoulder loosening and relaxing exercises should also be practised.

At a later date more complicated breathing and mobility

exercises along the lines suggested by the Asthma Research Council may be given

Commentary

The psychological factor in asthma is important. Worry, home conditions etc seem to play a part in the onset of attacks. Patients need sympathy and encouragement to persevere with the treatment.

Unfortunately it is impossible to tell beforehand whether relief is likely to follow the use of short wave or ultra violet light. But it can be stated definitely that few cases do not derive some benefit from exercises given by a skilled physiotherapist and then conscientiously carried on for a long period by the patients themselves.

2 Bronchitis Pneumonia Emphysema and Pleural Effusions

(i) *Short wave diathermy*—Bronchitis whether acute or chronic and pneumonia whether lobar unresolved bronchopneumonia or pneumonitis respond favourably and derive much benefit from applications of short wave diathermy.

Apparatus required

Short wave diathermy with pads only not discs
Spacing felts and towels

If a genuine inducto thermic apparatus is available this should be used in preference to pads.

Method—Two large pads are employed. If the patient is very restless it is best to place one of these pads under the pillow behind his back and the other over the bedclothes with a rubber hot water bottle almost empty on the pad. The physiotherapist can then keep the latter in position with her hand.

If an inducto thermic coil is available this should be placed outside the bedclothes additional spacing between the chest wall and the coil being provided if necessary by a folded piece of gamgee or thin eiderdown. The infected area of lung should be under the centre of the coil. In urgent cases treatment can be given for long periods of up to 20 minutes 3 times or more in the 24 hours.

Signs that the treatment is effective are slowing of the pulse

- (iv) Suitable physical procedures such as faradism and massage to combat wasting and preserve the tone of the muscles in the immediate vicinity of the burn.
- (v) Assisted active movements for the joints of the injured area, when the splints are removed temporarily for dressings. If thermostatically controlled saline baths are used, the bath period should be utilised for this treatment as the majority of movements are carried out more easily under water.
- (vi) Wax baths to improve the condition of the tissues and to assist the mobilisation of joints. These may be given with adequate precautions before healing is complete (page 160).
- (vii) Suspension exercises and other progressively active movements to obtain the full range of movement in the joints of the injured area when splints are discarded.

General Treatment

Badly burned patients also respond well in all stages of treatment to general physiotherapeutic measures. These should include general ultra violet irradiation. Every effort should be made by the institution of routine general exercises to improve muscle tone and circulation and to maintain a full range of movement in all joints not immobilised. Deep breathing exercises are important for promoting venous return. Remedial and diversionary occupation should play a useful role its value depending upon the ingenuity with which the occupation is adapted to the individual. All these patients should be encouraged to become ambulatory as soon as their local and general condition permits. The static attitude of mind is easily acquired during a long period of hospitalisation and may be difficult to overcome if allowed to persist. Many months of convalescence can be saved by the early establishment of a routine designed to promote independence and to encourage an interest in the speed of recovery. The state of chronic apathy so often seen in these patients is preventable and should be discouraged from the start. Here then is a field of vital importance for the physiotherapist.

THE COMMON CONTRACTURES

These are considered from the wrist upwards to the shoulder and from the hip down to the foot. The hand is dealt with

separately as it presents special problems. The principles of treatment given above apply to all the joints here considered but special points are noted under individual joints.

The Wrist

Burns of the wrist more frequently involve the extensor aspect and usually also involve the forearm and the dorsum of the hand. Flexion deformities resulting from gravity and the predominant flexor power across this joint occur even when the major incidence of the burn is on the extensor surface. Therefore on whichever aspect of the wrist a burn occurs the tendency is for the joint to assume the position of flexion. When a flexion deformity occurs in connection with a dorsal burn the causative agent is unrelieved spasm of the flexor muscle group. This position tends to be accentuated as healing occurs. The volar skin is dragged round on to the dorsum by the contracting scar producing a relative shortening on the volar aspect of the wrist if it is allowed to remain in flexion during this phase. The treatment is rest and splintage in a few degrees of extension and the early establishment of a full range of movement at the joint the splint being immediately replaced on the completion of the exercises.

The Elbow

Flexion deformities occur here and are due to scar contracture across the antecubital fossa or to shortening of the capsular and pericapsular tissues and of the biceps muscle. In the more severe cases of burning in the region of the elbow web scar bands are found which are highly resistant to stretching. As with all web scars if stretching is too violent epithelium over the thin scar breaks down and slowly healing ulcers form which result in more fibrous tissue being added to the web. In the early weeks of a burn in this region the movements of pronation and supination may be impaired or even lost. In the majority of cases this movement will recover completely without special treatment so that attention should in the main be directed to the prevention of flexion contractures.

The treatment is splintage and rest in extension. Care should be taken to see that full extension is maintained. Even

a few degrees of residual flexion deformity cannot be considered a good end result. This applies particularly to patients whose occupation entails carrying heavy weights as the carrying angle is obliterated over tiring of the flexor muscles occurs and ulceration of the stretched scar may well render them fit for light work only.

Successful physiotherapy will not result in the loss of any extension secured by the surgeon and in many cases improvement can be expected. It should never split a scar and it should be designed to secure the maximum range of movement consistent with the injury.

The Shoulder

Burns in this region if severe will produce an adduction deformity. Usually the burn involves the anterior aspect of the chest shoulder and upper arm. As healing progresses, the epithelium will grow straight across from the granulating surface on the chest to the arm if the two are allowed to lie in contact and so fusion of the chest and arm can occur almost to the elbow. The natural position for the arm to assume after a burn of this sort is adduction. Spasm in the pectoral and latissimus dorsi muscles will account for this and is of real importance in treatment. Every effort should be made to prevent this crippling adduction deformity (Fig 11 a b Plate VII). Standard abduction splintage is not applicable to every case as it interferes with dressings and nursing. Rest in abduction is desirable however and methods can be devised to meet this need. The arm must be slung at right angles to the trunk in a sling suspended from an overhead pulley. As with other joints movements should be instituted at the earliest opportunity and maintained until healing and stabilisation are complete.

With all upper limb burns the hand should be watched from the beginning. Edema should be controlled in the acute stage (page 75) and full movements of the fingers and thumb insisted upon throughout treatment. A successful result in an upper-arm burn is of little value if fingers are neglected until they are stiff and functionless.

The Hip

Severe burns in this area are uncommon but occasionally the inguinal region is involved in a full thickness skin destruction. In these cases scar web will form from abdomen to thigh unless the obvious preventive measures are employed, but it is seldom that deforming contractures result. When there is much skin destruction in the inguinal region the patient should be nursed on a frame or in a plaster bed during the early stages of healing. During the contractile phase of the scar full leg movements including hip extension exercises should be instituted. Until healing is complete a sitting position is contraindicated for these patients.

The Knee

This joint is usually involved in the common burns of the legs but the involvement of this joint is often overlooked owing to the many other indications for surgical and nursing treatment. Stiffness in the knee is an all too-frequent sequel of leg burns because of the lengthy period of immobilisation necessary until the raw surfaces are well advanced towards healing.

Splintage in a few degrees short of full extension is necessary. Static contractions of all muscles of the leg should be carried out by the patient from the very first. As soon as the skin condition permits faradism and active exercises should be given to all muscles that pass over the knee-joint including those from the calf. This treatment should be continued until walking is again possible. The deformities resulting from improper treatment are either flexion with inability to extend the knee or a hyper-extended genu recurvatum and a flail joint. These deformities arise so insidiously that great care must be taken in the splintage and exercise of the limb to ensure that these disasters do not occur. The physiotherapist must keep the surgeon constantly informed on these points. It is especially important with lower limb burns to maintain from the first the tone of the intrinsic muscles of the feet which are in the great majority of cases available for treatment by suitable faradic electrodes.

A special indication for wax bandages is found in third

degree burns of the legs particularly where the burn completely encircles the leg. In these cases healing is notoriously slow.

Occasionally when healing is complete there is a phase when the stability of the epithelium is poor and the tone of the underlying capillaries is lost. In this phase the patient is not normally allowed to assume an erect posture as haemorrhages are liable to occur under the epithelium. In a large percentage of cases these haematomata become infected more epithelium is destroyed ulceration occurs and the cycle of treatment has to be started again.

It has been found that wax bandages in the latter phase of healing help to stabilise both the epithelium and the underlying capillaries. The tendency to form haemorrhagic vesicles is minimised. It has in consequence been found that these bandages with their heat retaining and supporting properties help the patient to pass more safely through this danger period. For these cases the method of application is the same as that given for joints (page 172) but the temperature of the wax should be 110° F. This may be raised at successive treatments as the condition of the tissues improves. The bandage should be left on for 24 hours.

Foot and Ankle

This region is seldom the site of a burn except in children. As with the hand the foot may suffer from neglect during the treatment of an injury higher up the leg. Prophylactic measures should be instituted including adequate splintage and exercises designed to prevent the equinus deformity and claw toes which so readily develop. When once these deformities become static many of them are completely irreparable and the majority are unfortunately due to neglect of well established orthopaedic principles.

Ultra violet Light

Ultra violet light is employed in two types of burn:

- (a) Superficial.
- (b) Full thickness skin loss.

It is essential to make this division because the dosage in the two types is different although much of the technique is common to both.

In the treatment of superficial burns ultra violet light is found to be valuable in that it relieves the pain and discomfort associated with these partial thickness skin losses. It has a stabilising effect upon the new growing epithelial cells and in this way promotes an early return of normal skin function.

In large full thickness skin losses resulting from burns there often comes a phase when epithelial activity at the edges of the wound ceases. This may be due either to infection or to fibrosis in the base of the wound which diminishes the blood supply to the part. In the latter instance the granulations shrink and become atrophic they lose their healthy velvety lustre and become pale and poorly nourished. These wounds can often be stimulated to react if treated early by ultra violet light. Revascularisation then occurs and the epithelial growth again becomes evident.

(a) *Superficial Burns*

Apparatus required

(1) A portable mercury vapour lamp that will give a visible first-degree erythema at 30 ms in 2 minutes over the abdomen of an individual of medium colouring is suitable for all classes of first-degree burns. When more powerful apparatus is used the portable lamp should be taken as the standard basic dosage and necessary alterations in time and distance made.

(2) Dressing trolley laid with the following sterilised articles

- (a) 2 dressing bowls
- (b) 2 galley pots
- (c) 3 pairs of dressing forceps
- (d) 1 pair of scissors
- (e) Drum containing swabs gauze cotton wool and towels
- (f) Cheats forceps
- (g) Normal saline
- (h) Liquid paraffin.
- (i) Dirty-dressing bowl.

Method—A sterile towel is placed under the area the soiled dressing is removed and the wound cleaned with normal saline. The burned area is then sprayed or gently dabbed over with sterile liquid paraffin. The skin immediately surrounding the burn is protected by a narrow strip of cotton wool soaked in

normal saline. This method ensures an accurate outline of the edges of the wound. External to this the skin should be protected by dressing towels or dry cotton wool.

The ultra violet light lamp having been run up for at least 3 to 5 minutes the burned area is irradiated *at right angles* for 2 minutes at 26 ms so that a distance slightly less than that known to produce an erythema in 2 minutes. In circumferential wounds serial exposures must be given each at right angles to the surfaces of the limb. Fresh liquid paraffin is added wherever it is seen to be drying up. It is essential for the success of the technique that the ray should always pass through a film of paraffin. This becomes fluorescent under the action of ultra violet light so the emergent ray becomes longer than the incident ray and it appears to be this that is in some way responsible for the sedative and regenerative effects. Treatment should be given daily the duration of treatment should be kept at 2 minutes. A suitable dressing is then applied. When there are multiple burns each area should be treated separately.

Commentary

This method is successful in a high percentage of cases and clinical improvement and diminution of discomfort when dressings are changed should be evident even after the first treatment. If such improvement does not occur early further treatment is contra indicated.

(b) *Full thickness skin loss*—The apparatus and method of preparation are similar to those required for superficial burns, with the exception that the burned area is not sprayed with sterile liquid paraffin and the indolent skin edge is exposed to the extent of about $\frac{1}{8}$ in. The initial dose should be equivalent to double the standard first-degree erythema described above. Treatment should be given on alternate days and increased 1 minute per treatment to a maximum of 3 times the initial dose.

INJURIES OF THE HANDS

There is no doubt that all injuries affecting the function of the hands should receive physiotherapy as an integral part of treatment. Whatever type of injury may be present be it a

fracture burn laceration or infection the guiding principles of remedial treatment are similar.

Following injury there are two phases under which treatment can be considered. First the acute phase in which disturbance of the vascular system as evidenced by oedema should be controlled and secondly the recovery period during which prevention of deformity and re-education of function are the main interests of the therapist. This demands complete co-operation between surgeon and physiotherapist.

The Acute Stage

It cannot be sufficiently stressed that oedema is a potent cause of hand disabilities and that every effort should be made to prevent or minimise it during the first few days of treatment. The effects of uncontrolled oedema are due to tension in the tissues and to the massive deep-scar formation which occurs if its resolution is delayed. It is in fact a prime cause of the frozen hand. The mechanism of its occurrence is not fully understood but the fluid is filtered off from the blood stream through the abnormally permeable capillary endothelium into the tissue spaces. Here by osmosis the pressure may rise to such an extent as to occlude much of the capillary bed and the venous return. Thus a vicious circle is set up and the swelling perpetuated. If left to its own devices the oedema fluid is in part absorbed during the course of a few weeks but the remainder containing a high concentration of tissue breakdown products stimulates a fibrotic reaction which may be widespread throughout the hand. In this way it affects joint capsules, tendons and sheaths, intrinsic muscles and the perivascular supporting tissues. As this fibrous tissue contracts function becomes limited until in severe cases complete immobility may result.

The treatment of oedema consists firstly of elevating the arm to promote drainage by gravity. The hand should be above the level of the shoulder but the elbow should not be flexed beyond 90 degrees. There should be no constricting dressings or clothing round the upper arm. The simplest method of elevation is the incorporation of the hand and arm with the dressings in a light plaster cast with a hook let into the plaster by which the arm can be elevated to an overhead point. A common method of doing this is by means of a wooden stand

6 ft in height with a firm base at least 1 ft 6 ins square
Holes are bored at intervals of 3 ins to accommodate the suspension hook.

A pressure dressing should be used in all cases of oedema. It should consist of some malleable material such as wool soaked in paraffin flavine emulsion which is applied over the wound dressing evenly round each finger and on the palm and dorsum of the hand. This should be bandaged on with the greatest care using firm even pressure. The position of the hand will depend on the injury. Fracture alignment must take first place when bones are involved. In burns the position of rest should be adopted with 30 degrees of flexion in all digital joints, and the thumb in palmar abduction and opposition (Fig. 12). Special directions as to position should be given by the surgeon.

In all hand injuries movement should be instituted at the earliest moment except where it might interfere with the healing of a fracture or soft tissue laceration or where the resolution of an inflammatory process might be delayed. In some hands early movement is impossible by virtue of oedema, pain or splintage. The patients should be taught static contractions which will develop into active movements as the hand improves. Re-education of the fine co-ordinating movements necessary for proper use of the hand requires much time and patience. In many cases it entails the complete re-education of function in the hand. Few patients understand the movements involved and these should be analysed and taught as if the hand consisted of three separate components - 10 fingers, thenar and hypothenar units.

Fingers

Begin with flexion and extension of all joints singly then together. Adduction and abduction come next with the metacarpophalangeal joints in extension and with slight flexion of all interphalangeal joints. These should be followed by the compound movement of metacarpophalangeal flexion with interphalangeal extension and the reverse. This movement should be done with all four fingers moving together and then separately for each finger.

Thenar unit

Flexion and extension at interphalangeal joint

Flexion and extension at metacarpophalangeal joint

Flexion and extension at carpo-metacarpal joint
Adduction and abdnetion at carpo-metacarpal joint
Opposition and circumduction.

Hypothenar unit—As for the fingers but with the addition of opposition with or without the same movement in the thenar unit. The teaching of simultaneous thenar and hypothenar opposition is particularly necessary as it plays an important part in the palmar grasp. The patient can be encouraged to do this by the suggestion of their holding a drop of fluid in the palm of the hand.

Demonstration of these movements on the patient's uninjured hand will facilitate teaching and he should be instructed to carry them out as exercises for a few minutes every half hour. The intervening periods should be rest and relaxation.

Relaxation should be explained and a conscious effort should be made to relax all muscle groups. Tired muscles tend to go into spasm which is undesirable in all stages of treatment.

Where there is gross oedema following a severe injury such as a burn the positive pole of the direct current can be used in conjunction with other methods of treatment to control swelling. It can be demonstrated that fluids pass from the positive pole of a direct current to the negative pole (the phenomenon known as electro-osmose) and it is therefore not surprising to find that suitably placed electrodes help towards a reduction of the oedema.

In practice the anode suitably shielded by a saline pack is incorporated in the dressing to make contact with the fingers or hand and the cathode placed in the axilla. In cases selected for this treatment a saline and paraffin emulsion dressing is not used. A current of 0.5 to 1 m.a. is passed twice daily, half an hour being given for each treatment. The dressing can be kept suitably moist by injecting normal saline without removing the dressing. The results of this as with all physical treatments are better when used in the early stages.

The Later Phases

The restoration of lost function is the principle concern of the physiotherapist after the acute effects of trauma have subsided. The disability in the hand should be thoroughly analysed and methods of re-education and rehabilitation devised to suit each individual case. Success will largely depend

npon securing the full confidence and co-operation of the patient during all stages of treatment especially when movements may be painful and difficult

The key to restoration of lost movement is active exercise and the only differences are in the methods for the application of this principle. It can never be too strongly emphasised that there is absolutely no place for passive stretching and manipulations of the small joints of the hand. In the great majority of cases further loss of function will result from these procedures as the tissues torn by the force applied will heal by forming more scar tissue which is itself a barrier to movement. The principle of active movement can be applied either in the form of exercises or by means of a remedial occupation designed to restore the lost functions of the hand. A combination of both methods is advisable in most cases and constant supervision is necessary in order that changes in detail may be made as improvement occurs. The patient should be given some visible means of assessing his own improvement and this is most easily done by recording joint function on a small protractor and keeping the readings on a graph the meaning of which can easily be explained. Many patients can be taught to record their own movements and to keep the record in graph form. This also provides a useful method by which the efficacy of treatment can be measured. The relaxing effect of heat other than radiant-heat or infra red should be used as a routine in the treatment of hand injuries. Warm moving air is safe but a paraffin wax bath is better (See page 169)

Following a paraffin wax bath there is a period during which relaxation is maximal the patient should therefore be encouraged to go at once to his occupational therapy while his movements are still free. This sequence of treatment can be given once or twice daily and under these conditions rapid improvement is to be expected. When these patients reach the stage of being able to dispense with in patient treatment it will be found that many who are employed in suitable jobs will improve much more readily if they are sent back to work than if they are treated under out-patient conditions at a hospital. The encouragement of wage earning if the occupation is a suitable one is the best stimulus to improvement at this stage and a system of control should be arranged so that they are examined at intervals to check the therapeutic value of the work.

CHAPTER 5

EXERCISES AND GAMES FOR SMALL GROUPS

In the majority of hospitals the number of patients sent for exercise to a particular class at any one time is not large but unfortunately most of the recreational games which might be adapted for remedial use usually employ a large number of players. The following have been selected as they only require simple apparatus they can all be used when there are only a small number of players and where space is limited.

It is well to remember that many of the patients sent for class activity have not taken part in gymnastics previously also that the exercises and games are not compulsory. It is therefore of primary importance to make the patient realise that though under discipline he is being helped to help himself.

The classes must be made sufficiently attractive for the patient to enjoy them and when planning them the following points are worth remembering.

- (a) It is essential to plan each session
- (b) Exercises and games are better given during the same session
- (c) Games should be selected so that all the players are as active as possible during the game
- (d) Where possible classes should be of the same age-groups and of the same grade of mobility
- (e) The patients should be re-graded at weekly intervals so that those who are ready can be sent to a more advanced class
- (f) The class should be active for the whole session one form of activity passing straight on to the next. Rest periods which are essential in a fast keen moving class should be made a definite part of the session. Deep breathing as a class in positions of rest such as lying, sitting or slack standing will secure this.
- (g) Wherever practicable classes should be given in the open air.

In some of the games described below points for competing

teams have been mentioned. If a system can be introduced so that points can be accumulative between teams and classes over weekly periods an additional incentive to improvement is secured.

THE UPPER LIMB EXERCISES

The following lists are given as suggestions and not as gymnastic tables.

- 1 Forward lunge position—free arm swinging in all directions
- 2 Across bend stride standing—trunk rotation to alternate sides with arm flinging
- 3 Stride standing—double shoulder rolling
- 4 Neck rest standing—elbows forward and backward pressing
- 5 Stride standing both arms to same side—arm swinging sideways and upwards to alternate sides
- 6 Stoop stride standing—alternate arm swinging upwards and downwards
- 7 Wide grasp on wand stride standing—forward and upward lifting and placing behind back
- 8 Walk standing—arm punching in different directions change foot (also speed) at given command
- 9 Sawing in pairs walk standing—hands grasped elbows shoulder level slow sawing changing feet at given command gradually quickening the movement
- 10 Coffee grinding In pairs hands grasped—both turn inwards and outwards retaining grasp circling arms as they turn
- 11 In pairs back to back hands grasped—arms swinging sideways and upwards rhythmically increasing range
- 12 Skipping with variations to give additional arm movements e.g. forward and backward skipping doubles swinging rope to alternate sides and crossing

THE UPPER LIMB GAMES

Ball Catching and Bounding

Minimum number of players 2

Apparatus—1 or 2 small balls to each pair of players

Formation—In twos standing opposite to each other at least 9 ft apart

Game—Players use 1 ball and alternately throw and bounce to each other

Scoring—When there are only 2 players 1 player scores a point each time his opposite drops the ball. When a group is playing a point is given to the pair of players with the least number of dropped balls during a given period e.g. 2 minutes

Progression—Players use 2 balls and throw or bounce the balls together

Throwing Balls through a Hoop

Minimum number of players 3

Apparatus—1 or 2 small balls and 1 small hoop to each group of 3 players

Formation—In threes The outer players stand opposite to each other at least 9 ft apart the middle player holds the hoop at shoulder level

Game—The outer players throw the ball to each other through the hoop

Scoring—As for Ball Catching and Bouncing

Progression—The height of the hoop and the distance from the hoop may be increased 2 balls may be used at the same time

Throw and Catch

Minimum number of players 4

Apparatus—1 small ball or bean bag to each team of players 1 rope stretched across the room at a height of 4 ft and a distance of 3 yds from a starting line

Formation—In teams behind a starting line at one end of the room

Game—The 1st player throws the ball over the rope runs forward and dodges under the rope before catching the ball He then throws the ball to the next player and returns to the end of the line and the other players repeat the procedure The last player throws the ball to the 1st player and runs back to his original position

Scoring—1 point is scored by the 1st team to have all its players back to the starting line the 1st player holding the ball above his head

Wandering Ball

Minimum number of players 5

Apparatus — 1 small ball or bean bag

Formation — Circle 1 player in the centre

Game — The centre player endeavours to intercept the ball whilst it is being thrown between the other players the height and the direction of the passes should be varied as much as possible using low straight vigorous passes

Ball Bouncing Relay Race

Minimum number of players 4

Apparatus — 1 ball to each team

Formation — In teams behind a starting line at one end of the room

Game — The 1st player bounces the ball using alternate hands to the opposite end of the room and back to next player

Scoring — 1 point is scored by the 1st team to have all its players back to the starting line

Progression — Increase the size of the ball.

Volley Ball

Minimum number of players 8

Apparatus — 1 football 1 net or rope stretched across the room at a height of 6 ft 2 courts are made by chalking base lines at least 12 ft from the centre

Formation — 2 opposing teams either side of the net

Game — 1 player stands at the base line and throws the ball which is passed forwards by members of his own team using a flat hand (either hand or both may be used) and hit across the net aiming to hit the ground on the opponents court The opponents endeavour to prevent the ball striking the ground on their own court and hit back on to the servers court

Scoring — 1 point is scored each time the servers team hits the ball on to their opponents court If the opponents hit the ball on to the servers court they regain the point

Rocking the Dummy

This can be used for its amusing diversional value

Minimum number of players 3

Apparatus—None

Formation—In threes Outer players stand with right foot forward, forearms flexed elbows at shoulder level wrists palmar flexed

Game—Centre player stands with feet slightly apart and holds himself rigid whilst rocking from heel to toe Outer players endeavour to increase the range of his rock using their arms without extending their wrists The centre player should not be unbalanced

Floor Wrestling

Minimum number of players 2

Apparatus—None

Formation—In pairs prone lying head to head Partners grasp right or left hands elbows flexed and touching and resting on the floor forearms elevated

Game—At the word Go each player endeavours to force his partner's forearm outwards until it is flat on the floor

Chinese Boxing

Minimum number of players 2

Apparatus—None

Formation—In pairs Partners grasp opposite wrists.

Game—With his free open hand each player attempts to touch his partner's face

Danish Wrestling

Minimum number of players 2

Apparatus—None

Formation—In pairs Partners grasp right hands place right feet forwards with outer borders of feet touching

Game—Wrestle to force opponent to move his right foot Change to left hand grasp left foot forward

THE LOWER LIMB NON WEIGHT BEARING EXERCISES

- 1 Lying bicycling
- 2 Lying dorsiflexion of ankles and inversion of feet with head raising
- 3 Lying alternate leg circling

- 4 Lying alternate knee bending hands clasped under thigh knee flexion to 6 counts allowing weight of limb to accentuate movement followed by knee extension straight leg lowering
- 5 Prone lying alternate knee bending and stretching
- 6 Prone lying double knee bending grasp ankles try and increase flexion
- 7 Crook sitting grasping toe alternate knee straightening
- 8 Cross leg sitting double knee outpressing
- 9 Crook sitting in pairs with soles of feet touching alternate knee bending and stretching against partner's resistance
- 10 Stride sitting on form alternate leg lifting on to form
- 11 Low wide grasp on wand long sitting alternate knee flexion place leg over wand so that heel touches floor
- 12 Long sitting alternate leg raising figure of eight or name writing in the air

THE LOWER LIMB NON WEIGHT BEARING GAMES

Ball Passing

Minimum number of players 0

Apparatus—1 small ball to each team

Formation—Long sitting in teams side by side

Game.—1st player holds the ball between his ankles and passes to the next player who grips it between his ankles and passes it on

Scoring—1 point to the winning team

Band Passing

Minimum number of players 0

Apparatus—1 webbing band approximately 36 ins long by 2 ins wide to each team

Formation—Long sitting in teams

Game—1st player places the band on his foot and by leg circling passes it to the next player and so on. The band may be passed from right foot to right foot or left leg across the body.

Scoring—1 point to the winning team

Kicking the Bean Bag

Minimum number of players 2

Apparatus—1 bean bag to each pair of players

Formation—Crook sitting facing partner at least 18 ins apart

Game.—1st player places the bean bag oo his feet and throws it across to his partner who must catch it oo his feet

Scoring—When there are only 2 players one point is scored for 6 consecutive throws. When a group is playing a point is scored by the pair of players with the greatest number of consecutive passes.

Progression—Increase the distance between the players up to 4 ft

Kicking the Ball

Minimum uumber of players 2

Apparatus—1 small ball to each pair of players.

Formation—Crook sitting opposite partner at least 12 ft apart

Game—1st player using the injured limb kicks the ball to his partner who must return it in the same way

Scoring—As for Kicking the Bean Bag

Progression—Increase the distaoce between the players up to 24 ft

Overhead Leg Passing

Minimum number of players 6

Apparatus—1 bean bag to each team

Formation—Crook sitting in teams

Game—1st player holds the bean bag between his feet and rolls over backwards passing the bean bag over his head to the next player who grips it between his feet and so on

Scoring—1 point to the winning team

Windmill

Minimum number of players, 2

Apparatus—None

Formation—Long sitting facing partner lower legs side by side

Game—Both players work together Double leg circling over and under partner's legs without touching

Scoring—1 point to the player with the greatest number of consecutive passes without touching his partner

THE LOWER LIMB WEIGHT BEARING EXERCISES

- 1 Prone kneeling change through knee sitting to standing
- 2 Standing alternate arm and leg swinging forwards and backwards
- 3 Wing standing heel raising knees bending to curtsey sitting alternate leg stretching sideways
- 4 Forward lunge position both hands on knee knee pressing forward
- 5 Wing standing alternate leg forward raising sideways and backwards circling
- 6 Marching alternately on toes and heels
- 7 Stepping on and off forms followed by jumping progressing to bunny jumping from side to side of form (moving along)
- 8 Running on the spot with deep knee bending backwards
- 9 Curtsey sitting jump upwards fully extending arms and legs return to starting position
- 10 Standing alternate toe and heel raising whilst abducting legs into stride standing
- 11 Skipping With variations to give additional leg movements Using one large rope players skip through in turn. Progress to number of skips speed of rope etc
- 12 Circle Hopping on one foot propel a ball with the other foot Stop at word of command

THE LOWER LIMB WEIGHT BEARING GAMES

Circular Skipping

Minimum number of players 2

Apparatus—1 length of stout rope at least 8 ft in length weighted at one end

Formation—Circle 1 player in the centre

Game—The centre player swings the rope in a circle about 8 ins from the floor the outer player jumping to avoid it

Scoring—When a player is caught by the rope he loses 1 point but continues jumping

Progression—Increase the height and speed of the rope swing. Note if the player does not clear the rope it will wind round his legs he should therefore immediately drop into curtsey sitting to avoid falling

Circle Target Throwing

Minimum number of players 8

Apparatus—1 small ball to each circle of players

Formation—Circle 1 player in the centre outer players in stride standing

Game—The centre player endeavours to throw the ball between the legs of the outer players who move their legs to prevent the ball from passing. When a player fails to stop the ball he changes places with the centre player

Making Runs

Minimum number of players 4

Apparatus—None

Formation—In pairs partners face each other at opposite sides of the room

Game.—At a given signal the players on one side of the room run to touch their partners outstretched hand and back to the starting point repeating the runs as many times as possible before Halt is called.

Scoring—1 point to the player or pair of players with the greatest number of runs

Rope Obstacle Relay

Minimum number of players 6

Apparatus—2 lengths of rope or cord at least 9 ft long to each team. At one-third of the distance along the room the first ropes are placed at a height of 2 ft 0 ins. At two-thirds of the distance the second ropes are placed at a height of 1 ft 8 ins

Formation—In teams behind a starting-line at the end of the room near the high ropes

Game.—1st player runs forward jumping over the 1st rope and passing under the 2nd on to the end of the room turns and runs back to the next player

Scoring—1 point is scored by the 1st team to have all its players back to the starting line

Dribbling Relay

Minimum number of players 2

Apparatus—1 football to each team of players.

Formation—In teams behind a starting line at one end of the room

Game—The 1st player dribbles the football to the opposite end of the room and back to the next player

Scoring—1 point is scored by the 1st team to have all its players back to the starting line

Progression—Place 2 or more skittles or chairs may be substituted, along the track so that the ball can be dribbled round them in a figure-of-eight pattern.

French Touch

Minimum number of players 4

Apparatus—None

Formation—Free formation

Game—1 player chases another when touched the 2nd player holds with one hand the part of the body that was touched and becomes the chaser

Team Passing

Minimum number of players 4

Apparatus—1 football.

Formation—In 2 teams free formation.

Game—The players of 1 team pass the football to each other using low passes whilst the players of the opposing team try to intercept the ball. When intercepted the 2nd team pass whilst the 1st team attempt to regain the ball

Scoring—1 point is given to the team with the greatest number of consecutive passes over a given period.

Ground Hand Ball

Minimum number of players 4

Apparatus —1 football.

Formation —In 2 teams free formation. The opposing teams play to a goal marked at each end of the room

Game —The game is started from the centre of the room the 1st team attempt to pass the ball to their goal by patting it with one hand, along the floor. The 2nd team try and intercept the ball and pass it to their own goal.

Scoring —1 point for each goal scored.

Boat Race

Minimum number of players 8

Apparatus —None

Formation —In teams behind a starting line at one end of the room in curtsey sitting position grasping the waist of the player in front. A leader stands facing his team holding the hands of the 1st player

Game —The leader coaches his team to move forwards for a given short distance by a series of cohesive jumps

Scoring —1 point to the 1st team to reach its objective

Mark and Dodge

Minimum number of players 2

Apparatus —None

Formation —In pairs free formation

Game —1 player walks freely about the room and is marked by his partner who attempts to keep within arm distance all the time. At a signal both players stand still when the marker should be near his partner

Progression —(a) Running (b) Hopping (c) Ankle grasp walking (d) Crouch hopping

Medley Relay

Minimum number of players 6

Apparatus —1 chair to each team of players

Formation —In teams behind a starting line at one end of

the room. A chair is placed at any desired distance opposite each team

Game — The corresponding players of each team are numbered off so that each set moves in a different manner according to instructions e.g. 1 hopping 1 running backwards skip jumping running on all fours etc. The 1st player proceeds forward round the chair and back to the next player

Scoring — 1 point is scored by the 1st team to have all its players back to the starting line

Ones and Twos

Minimum number of players 6

Apparatus — None

Formation — Circle with a fairly large space between each player. 2 players stand 6 ft. outside the circle and 3 ft. from each other

Game — At a signal both players outside the circle start walking number 1 chasing number 2 who must get home by standing in front of 1 of the players forming the circle. This player is then chased and must again try and stand in front of 1 of the players forming the circle. The player who is caught becomes the chaser

Progression — (a) Hopping (b) Running

BACK MOBILISING EXERCISES

- 1 Lying heels and shoulders pressing on to floor Back arching
- 2 Crook lying double knee swinging to alternate sides with arm swinging to opposite side
- 3 Prone lying hands on floor at shoulder level, double arm stretching to prone falling
- 4 Cross leg sitting hands grasping ankles Trunk bending downwards slowly raising and changing to yard long sitting
- 5 Cross leg sitting trunk rotation to alternate side with double arm swinging fingers striking floor
- 6 Crook sitting in pairs back to back with arms linked alternate back arching over partner

- 7 Long sitting trunk bending downwards with arm circling backwards to touch opposite foot
- 8 Prone kneeling trunk and head bending forward with knee bending upward to touch head Leg lifting backward with trunk arching backward
- 9 Wide grasp on wand, standing Trunk bending forward and downwards followed by knee bending upwards to step over wand. Return to starting position
- 10 Stride standing Trunk bending to alternate sides with arm swinging overhead.
- 11 Yard standing change to yard horizontal half standing
- 12 Caterpillar walk Prone lying hands on floor at shoulder level, double arm stretching to prone falling walk with straight legs towards hands then move hands forward to prone falling

BACK MOBILISING AND STRENGTHENING GAMES

Arch Ball

Minimum number of players 6

Apparatus — 1 football to each team of players

Formation — In teams

Game — 1st player holding the ball with both hands raises it over his head and arches back to pass it on to the next player who passes it on in the same manner. The last player receives the ball and runs to the front of the team the game proceeds until the 1st player again heads the team and holds the ball above his head

Scoring — 1 point to the 1st team to complete the cycle

Progression — 1st player passes the ball overhead 2nd player between his legs and so on to the end of the line Use a medicine ball

Tunnel Ball

Minimum number of players 6

Apparatus — 1 football to each team

Formation — In teams players in stride standing and spaced at least 3 ft apart

Game — 1st player throws the ball between his legs to the next player who passes it on in the same manner. The last

player receives the ball and runs to the front of the team the game proceeds until the 1st player again heads the team

Scoring — 1 point to the 1st team to complete the cycle

Progression — Use a medicine ball

Wheelbarrow

Minimum number of players 4

Apparatus — None

Formation — In pairs behind a starting line at one end of the room 1 player takes the prone falling position his partner stands behind and grasps both his thighs supporting them either side of his own hips

Game — Each pair of players races to the opposite end of the room

Scoring — 1 point to the 1st pair of players to reach their goal

Progression — Pairs changing places half way

Gate Crashing

Minimum number of players 4

Apparatus — 1 rope ring to each 4 players made by splicing together the ends of 8 yds of stout rope

Formation — In circle 4 players evenly spaced wide grasp the rope

Game — The players simultaneously climb over the rope and raise their arms backwards above the head to bring the rope back to the starting position

Scoring — When only 1 group is playing 1 point is scored if the movements are completed during a given number of counts When teams are playing 1 point is given to the first team to complete the cycle

Back to Back Pushing

Minimum number of players 2

Apparatus — None

Formation — Crook sitting in pairs back to back with arms linked

Game — Each player simultaneously attempts to push his partner forward

Circle Target Throwing (Variation)

Minimum number of players 8

Apparatus—1 small ball to each circle of players

Formation—Widely spaced in circle players in stride standing

Game—Any player in the circle endeavours to throw the ball between the legs of any other player excepting his neighbour. The other player attempts to prevent this by bending down to stop the ball with his hands but he may not do so until the ball is actually thrown and he must not bend his knees.

Scoring—When a player fails to stop the ball he loses 1 point

Obstacle Relay

Minimum number of players 4

Apparatus—1 table to each team of players. The tables are placed near one end of the room

Formation—In teams behind a starting line at the opposite end of the room from the tables

Game—The 1st player runs to the table crawls underneath and runs back to the next player

Scoring—1 point is scored by the 1st team to have all its players back to the starting line

Progression—The players crawl under and then over the table

Variation—The players carry a ping pong ball balanced on a bat. The bat and ball are passed under a rope placed at a height of 8 ins from the ground at any desired distance from the starting line whilst the player steps over the rope

Hoop Relay

Minimum number of players 4

Apparatus—1 small hoop to each team of players or a 4-ft length of rope spliced at both ends to form a ring may be substituted

Formation—In teams behind a starting-line at one end of the room. The hoops are placed at the opposite end.

Game—The 1st player runs to the hoop picks it up pulls it over his head and gets through and after leaving the hoop in place runs back to the next player

Scoring—1 point to the 1st team to have all its players back to the starting line

Variation—Stand in the hoop and pull it up over the body

Run and Throw

Minimum number of players 6

Apparatus—1 football to each team of players

Formation—In teams behind a starting line at one end of the room

Game—1st player runs with the ball, to a given mark and, with his back to his team throws the ball between his legs to the next player, who repeats this. When the last player begins to run the 1st player gets into position behind the starting line to receive the ball from him

Scoring—1 point to the first team to complete the cycle

Progression—Use a medicine ball

Variation—A rope 1 ft high is placed at any desired distance along the room between the two running points. The players crawl under the rope run to the given mark and throw as before but they must clear the rope with the ball

Zigzag Ball Passing Relay

Minimum number of players 8

Apparatus—1 football to each team of players

Formation—In teams the players are spaced 1 yd apart each player on a marked spot facing alternately in opposite directions

Game—The players pass the ball zigzag fashion down the team the end player runs to the head of the team the other players meanwhile moving down one place

Scoring—1 point to the 1st team to complete the cycle

Variations—(a) sitting on chairs (b) sitting on the floor

Ground Hand ball Relay

Minimum number of players 6

Apparatus—1 football and 3 lengths of rope at least 9 ft long to each team of players. If ropes are not available chairs can be used as an alternative. The length of the room

is divided into thirds and the ropes placed across at these points at a height of 1 ft from the ground

Formation—In teams behind a starting line at one end of the room

Game—The first player rolls the ball forwards using one hand the ball is rolled under the ropes whilst the player steps over the ropes he then picks up the ball and runs back to the team and hands the ball to the next player who repeats this

Scoring—1 point to the 1st team to have all its players back to the starting line

Skinning the Snake

Minimum number of players 8

Apparatus—None

Formation—In 2 teams players in stoop stride standing Each player passes his right hand backwards between his legs to grasp the left hand of the player behind.

Game—At a given signal, the end player lies on his back whilst the other players move backward keeping in the stride standing position. Each player sits then lies down as soon as he has passed over the head of the player behind him the legs are then held close to the sides of the player in front The last player to lie down immediately rises up again and moves forward to the front of the team the others rising in turn The hands must be held throughout the game

Scoring—1 point to the 1st team to complete the double cycle

CHAPTER 6

EXERCISES FOR ABDOMINAL CONDITIONS

EXERCISES for abdominal conditions fall into two main groups those prescribed for *medical* and those prescribed for *pre and post-operative cases*

EXERCISES FOR MEDICAL CONDITIONS

Exercises which are given in medical cases are too well known to physiotherapists to require detailed discussion. It is advisable however to say a special word about patients suffering from gastric or duodenal ulcer. The policy in the past when treating these patients in hospital has been to keep them completely at rest but latterly the value of maintaining and improving the muscle tone is becoming increasingly recognised.

Before beginning any scheme a note should be made of the diet chart so that the exercises should be given just before a feed is due. They should be given at least twice daily. These patients are usually mentally and physically tense and it is therefore important to give instruction in deep breathing and in relaxation before starting any head, arm or leg exercises. Abdominal exercises however should begin with static contractions to eliminate the risk of breaking down adhesions around any ulcer and the danger of haematemesis and/or perforation. As the condition of the patient improves all the exercises are carefully upgraded. In the case of the abdominal muscles the outer range of movement should be introduced cautiously.

Pre- and Post-operative Exercises

In the past the method of teaching tables of abdominal exercises to students of physiotherapy has been based on the particular condition concerned e.g. cholecystectomy. As rehabilitation exercises chiefly concern the abdominal musculature it is clearly of greater importance to construct tables in relation to the surgeon's approach through the abdominal wall.

rather than in relation to the organ. This section therefore deals with post-operative abdominal exercises from this angle and not from the angle of the diseased condition.

Pre- and post-operative exercises have certain aims which are common to all the conditions treated, irrespective of the particular operation. These aims are as follows:

A. During the Pre-operative Stage

- 1 To inspire the patient with confidence in his own ability to help himself
- 2 To obtain a full expansion of the lungs and a mobile thoracic cage
- 3 To teach the first simple exercises which will form part of the post-operative scheme
- 4 To strengthen the muscles which will be incised at operation.

B. During the Post-operative Stage

- 1 To re-establish full use of the thorax
- 2 To maintain the circulation particularly in the lower limbs thus reducing the danger of thrombus or embolism
- 3 To restore and improve the muscle tone so that the patient will not feel weak and giddy when he first rises from his bed.
- 4 To improve the posture which is often poor as a result of previous ill health
- 5 To grade the patient up to class activity and games in competition with other patients so as to reduce the period of convalescent lassitude to a minimum.

In connection with these two stages it is important to note the following general rules:

During the Pre-operative Stage

- (a) The teaching of efficient lung movement forms the most important part of treatment and will go far towards preventing post-operative chest complications.
- (b) Breathing should be taught as described on page 53 particular attention being paid to expanding the bases of the lungs diaphragmatic breathing and mobilising exercises. It is essential that time and patience should be spent on these exercises so that the patient can co-operate after his operation without undue mental effort i.e. while he is still under the influence of drugs.
- (c) In most instances patients are admitted 3 or 4 days prior to operation and whenever possible treatment should be carried out twice daily during this period.
- (d) The aims and reasons for the exercises should always be care

fully explained in simple language, and it will be found that patients are very willing to co-operate as it gives them something positive to do at a time when they are feeling anxious and their role is mainly passive.

During the Post-operative Stage

- (a) Post-operative breathing exercises should always begin the day after operation, unless there is marked post-operative disturbance or other complication. It is imperative as soon as possible to re-establish the diaphragmatic reflex which tends to become lost, particularly after operations affecting the upper abdomen, such as a partial gastrectomy or cholecystectomy.
- (b) Patients who develop a post-operative cough require special care and attention, as the condition is both painful and distressing particularly if there is mucus in the air passages which the patient finds difficulty in expectorating due to the strain on the wound. The physiotherapist can materially assist this by placing one hand gently but firmly over the bandage to give support. If the patient has great difficulty in expectorating and it is thought that mucus is collecting the permission of the surgeon should be asked to carry out the following procedure.

The patient should lie on the side with the knees flexed and the foot of the bed raised on 12 in. blocks. He may place one hand over the bandage for support, while the physiotherapist places one hand over the region of the diaphragm and with the other supports the back. The physiotherapist should then encourage the patient to breathe deeply and make the effort to expel the mucus.

- (c) Breathing exercises should be carried out 3 times a day and should be timed so that they precede by a short interval the post-operative drug which is usually given at 4 hourly or 6-hourly intervals.
- (d) A gradually progressive table of exercises should be instituted as soon as the general condition of the patient permits. The time for this will obviously vary with the severity of the operation and the state of the individual patient. With the permission of the surgeon, the majority of patients can safely begin the exercises from the 1st to the 3rd post-operative day. As the scheme progresses breathing exercises can be correspondingly reduced, unless there are special reasons for continuing them.
- (e) The scheme of exercises should be given at least twice daily and the patient instructed to do simple movements in between. The number of times that individual exercises are performed will naturally vary with each patient.

ABDOMINAL INCISIONS

When preparing a scheme of post-operative exercises consideration should be given to the type of incision used and the muscles involved. Surgeons naturally vary in their individual

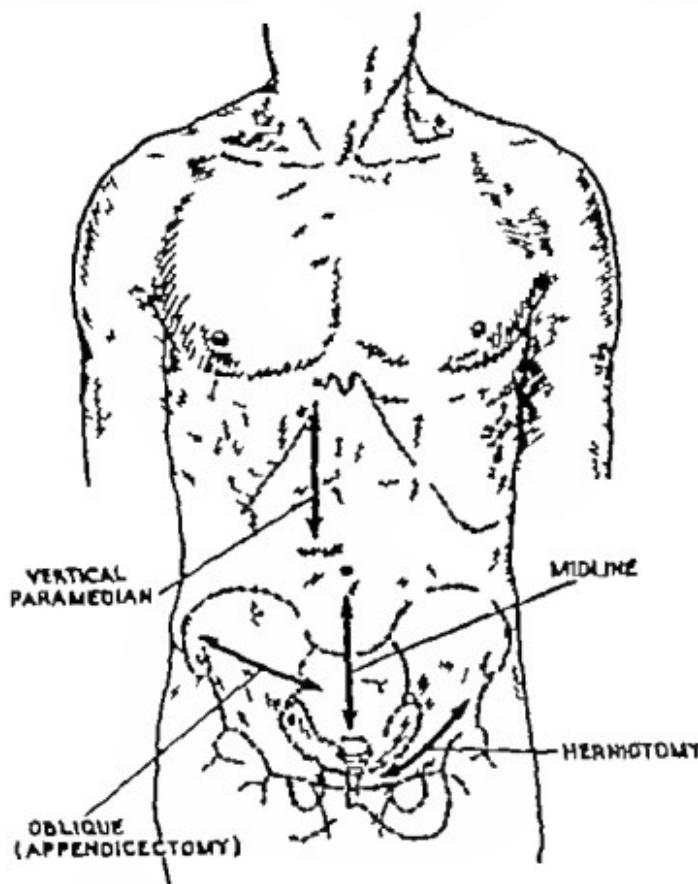


FIG. 13.—Types and position of abdominal incisions.

individual technique but it will be found that the two most common incisions (Fig. 13) are

- A Vertical (in which fibrous healing occurs)
- B Oblique or muscle splitting (in which fibrous healing does not play a prominent part)

The matter is important from the physiotherapist's point of view because fibrous tissue healing is slow so that 2 to 3 weeks must elapse before full movements are allowed whereas

incisions through muscles heal rapidly and full movement can be allowed within a week.

A. Vertical Incisions

The type of vertical incision most frequently employed is the paramedian. In the upper abdomen it is usually made from the costal margin to a point one side of the umbilicus or short of this point. A right upper paramedian incision is used for approaching the stomach duodenum and the gall bladder; a left upper paramedian incision for an exploratory laparotomy. A lower paramedian incision is made from one side of the umbilicus to above the symphysis pubis or short of this point and is used for approaching the intestines and colon. A median incision is however used for approaching the pelvic organs as it allows of an easier access to both sides.

In each case the anterior rectus sheath is incised the rectus muscle is retracted outwards and an incision is then made in the posterior rectus sheath and peritoneum into the abdomen.

It should be remembered that the anterior and posterior rectus sheaths are, to all intents and purposes the tendons of insertion of the oblique muscles of the abdomen whose pull is from the mid line outwards. When these sheaths are cut all abdominal movements tend to pull the suture line apart. As previously stated, fibrous tissue healing is comparatively slow and time must therefore be allowed before painless, powerful abdominal movements can be given.

The paramedian incision has the great advantage of not destroying the motor nerve supply to the rectus muscle thus avoiding loss of muscle tone.

B. Oblique Incisions

Oblique incisions involve muscle splitting or muscle cutting in the line of the nerves. The oblique muscles are split in the line of their fibres so that healing occurs with the minimum loss of muscle tissue. If the muscles are cut so that the nerve supply remains intact muscle weakness is only temporary. This type of incision is usually used for an appendicectomy and the repair of inguinal and femoral herniae. The muscles involved by the vertical and oblique types of incision and the direction of their pull is shown in (Fig. 14 Plate VIII).

Appendectomy

The incision is usually 2 to 3 ins in length and is made from near the anterior superior spine downwards in a medial direction the external oblique internal oblique and transversalis muscles are split for the required length

Inguinal Herniotomy

The incision is usually made half an inch above and parallel to Poupart's ligament the length varies from 5 to 6 ins A simple repair consists of dividing the external oblique muscle ligating the hernia sac and repairing the inguinal canal by stitching the conjoint tendon to Poupart's ligament

Inguinal Herniorraphy

In this type of repair further strength is provided by grafting the conjoint tendon and Poupart's ligament with fascia or by transplanting a section of the anterior rectus sheath

Femoral Herniotomy

The incision is usually 3 ins in length and passes in the same line as the inguinal incision but a little lower The types of repair are similar to those used for an inguinal hernia.

METHODS OF CLOSING THE ABDOMEN

A After Vertical Incisions

The abdomen is closed in four layers the peritoneum by continuous catgut sutures and the posterior and anterior rectus sheaths are stitched separately by interrupted or continuous sutures These stitches are absorbed in situ The skin is approximated by interrupted or continuous sutures of non absorbent silk-worm-gut or other material which are removed from the 10th to 14th post-operative day Deep tension sutures may or may not be used according to the technique of the individual surgeon and whether there is likely to be much intra abdominal tension Most surgeons only take them as far as the anterior rectus sheath but occasionally the peritoneum is included The sutures are usually removed from the 5th to 14th post-operative day They always give the patient a certain amount of discomfort particularly when lost for the

maximum period. Allowance should be made for this when exercises are being given

B After Oblique Incisions

The abdomen is closed in layers i.e. peritoneum muscle layers and skin using the same type of sutures as for a vertical incision

If post-operative exercises are considered in relationship to the incision it will be found that a basic scheme of exercises can be built up to cover a number of specific operations

Thus Scheme I below has proved of practical value for patients on whom a paramedian incision has been used for such operations as a partial gastrectomy gastro-enterostomy cholecystectomy and exploratory laparotomy. Suitable modifications are made in the scheme where necessary to suit the needs of individual patients

Scheme II, Part I has been used successfully for patients following an appendicectomy or herniotomy. Scheme II Part 2 is used when a herniorraphy has been performed, in which case the patient is usually confined to bed for a full 3 weeks. The crook half lying position has been used for a number of exercises in the scheme but it should be remembered that some surgeons prefer their patients to be kept flat after a hernia repair. In these cases the crook lying position should be substituted

POST-OPERATIVE EXERCISES

Scheme I

1st to 3rd day

Half lying localised breathing exercises head movements in all directions as soon as possible

4th day

Exercise 1 Half lying toe clawing foot and ankle movements combined with finger and wrist movements

5th day

Exercise 2 Half lying quadriceps and hamstring contractions.

Exercise 3 Half lying abdominal contractions on expirations

Exercise 4 Half lying shoulder rolling with breathing

6th day

Exercise 5 Half lying alternate knee updrawing

Exercise 6 Half lying chest mobilising from side to side with knuckles on ribs

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7th and 8th days

Exercise 7 Half lying alternate trunk rotation with arm stretching across chest

Exercise 8 Half wing half neck rest trunk side flexion with breathing

9th day

Exercise 9 Hand support on bed gluteal contractions with pelvic raising anal impressing and adduction of thighs

10th and 11th days

Exercise 10 Long sitting toe touching

Exercise 11 Long sitting back arching with breathing

12th and 13th days

For Exercise 6 substitute crook lying alternate knee updrawing raising to vertical lowering to crook position.

For Exercise 2 substitute crook lying double knee abduction and adduction.

14th and 15th days

For Exercise 8 substitute across bend sitting alternate trunk rotation with arm flinging Add

Exercise 12. Wing sitting trunk backward falling and raising

16th and 17th days

Exercise 13 Relax stoop stride standing general correcting position.

Exercise 14 Wing standing alternate leg backward stretching

18th to 21st days

For Exercise 8 substitute neck rest standing alternate trunk rotation

For Exercise 14 substitute wing standing heels raising knee bending

For Exercise 13 substitute astride standing hewing

From the 14th day as many exercises as possible to be performed sitting on the side of the bed

POST-OPERATIVE EXERCISES

Scheme II

1 ART 1

Simple repair of hernia Patient up on the 14th day

1st day

Exercise 1 Crook half lying deep breathing with abdominal contractions on expiration.

Exercise 2 Crook half lying abdominal contractions followed by head raising

2nd day

Exercise 3 Half lying toe clawing foot and ankle movements, quadriceps and gluteal contractions.

Exercise 4. Half lying shoulder rolling with breathing

3rd day

Exercise 5 Crook half lying alternate knee updrawing

Exercise 6 Half lying alternate trunk rotation with arm stretching across chest.

4th day

Exercise 7 Crook half lying double knee abduction and impressing.

Exercise 8 Half lying double arm raising alternate upstretching followed by backward pressing

5th day

Change starting position of Exercise 2 to crook lying

6th day

Change starting position of Exercise 3 to long sitting

Change starting position of Exercise 5 to crook lying

7th day

Exercise 9 Crook lying alternate knee straightening raising to vertical, lowering to crook position.

Exercise 10 Crook sitting back raising vertebra by vertebra, with breathing

8th day

Exercise 11 Crook lying double knee rolling to alternate sides.

9th day

Exercise 12 Crook sitting chest rolling followed by breathing in all parts of thorax.

10th day

Repeat Scheme

11th day

Change starting position of Exercises 2 and 5 to lying

Change starting position of Exercise 11 to double knee raised on to chest

12th day

Change starting position of Exercises 6 10 and 12 to sitting on side of bed.

13th day

Exercise 5—substitute lying double knee raising

14th day

Repeat Scheme

PART 2

Fascial repair Patient up on the 21st day

1st to 10th days Scheme as given in Part 1

11th and 12th days

Change starting position of Exercise 5 to lying

13th and 14th days

Change exercise 5 to crook lying double knee raising

15th and 16th days

Change Exercise 9 to lying cycling

17th to 21st days

As many exercises as possible should be performed sitting on the side of the bed.

Since the focal point for throwing is the abdominal region bean bag or ball throwing may be included from the 3rd day if desired to give variety to the scheme

CHAPTER 7

SUSPENSION THERAPY

In this chapter the important contribution to rehabilitation by the methods introduced by Mrs Guthrie-Smith¹ is considered under the following headings

- (1) Definition.
- (2) Apparatus and Equipment.
- (3) General Principles —
 - (a) Mechanical.
 - (b) Psychological.
 - (c) Relaxational.
 - (d) Physiological.
- (4) Principles of Application —
 - (a) Simple suspension without springs
 - (b) Suspension with short tension springs.
 - (c) Suspension with long spiral springs
 - (d) Resistance with springs
- (5) Some conditions benefited by Suspension Therapy
 - (A) Orthopaedic Conditions —
 - (a) Recent injuries
 - (b) Smith Petersen Nailing for fractured neck of femur
 - (c) Sacro-iliac strain.
 - (d) Scoliosis
 - (e) Kyphosis
 - (B) Rheumatic Conditions —
 - (a) Non-articular cases Lumbago
 - (b) Articular cases Spondylitis chronic arthritis.
 - (C) Nerve Conditions —
 - (a) Flaccid paralyses
 - (b) Spastic paralyses

I Definition

Suspension therapy embraces a system of exercises to be carried out with the help of apparatus. The apparatus designed and advocated by Mrs Guthrie-Smith is essentially a rigid frame erected round a bed, so that part or the whole body can be suspended by strong canvas belts and adjusted by hooks

The reader is referred for the full description of this method to *Rehabilitation, Re-Education and Remedial Exercises*, by Olive F. Guthrie-Smith, M.B.E. C.S.P. T.M.O. (published by Messrs. Baillière Tindall & Cox).

or pillows from its cross bars. Its construction is such that movements can be regained by diminishing external resistance and muscles strengthened by graduated voluntary effort. Later developments incorporating the use of spiral springs are now known as eutonic exercises—they provide improvements and refinements some of which are of great psychological value.

2 Apparatus and Equipment

For general use in a physiotherapy department the Standard steel frame is the most suitable (Fig. 15 (a)). It

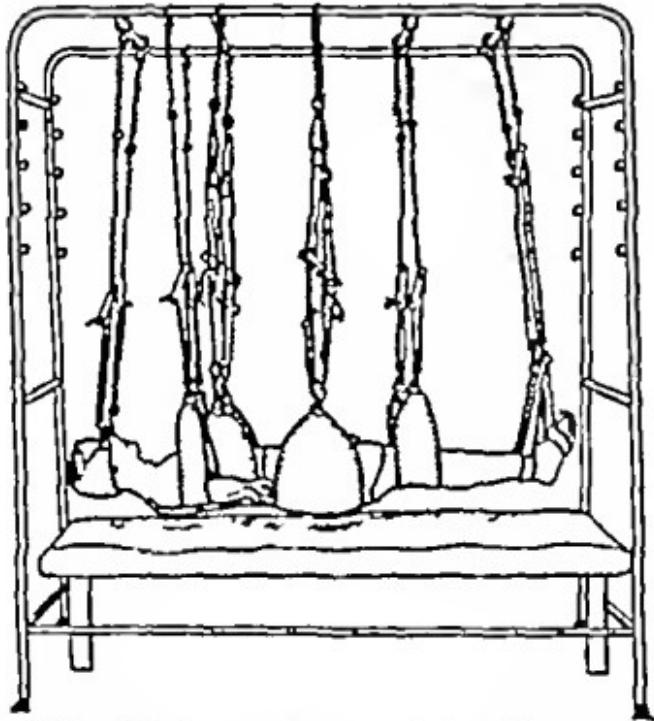


FIG. 15 (a) — (1) Complete frame and equipment shown in use. (u) Spondylitis. Total body suspension with use of short tension springs to obtain relaxation. (For description see page 105.)

can be left movable or fixed to the floor. The frame consists of light gauge steel tubing 1½ in. in diameter. It is made in the following five parts to facilitate portability:

- The overhead unit
- 2 end units
- 2 low bars which unite the end units near the floor

Note. The feet of the end units may have wheels attached which can be swung under when the frame is to be moved.

8 connections require to be made i.e. at the ends of the overhead unit and the two ends of each lower bar—this is effected by 8 bolts and their nuts.

The standard dimensions are

Height 7 ft 0 ins	Width at base 3 ft 6 ins
Length at base 8 ft 0 ins	Width at top 2 ft. 0 ins

(a) The overhead unit has 5 cross bars, 1 central and the others placed equal distances from the centre.

All of the overhead unit is notched at 1 in. intervals to provide anchorage for the hooks that hold the suspension ropes. Each closed section is supplied with at least 2 metal S hooks, 3 by 2 ins. making a total of 18 or more.

(b) The end units have 3 cross bars situated 7 ins., 3 ft 6 ins. and 6 ft 6 ins. from the ground. One of the low cross bars may be made to open to enable the frame to be wheeled over a bed. The vertical bars should have 10 permanent screwed in hooks placed at intervals of 5 ins. from the top cross-bar.

(c) The bars which unite the end units near the floor are situated 7 ins. from the ground, and are also notched on the under surface each bar being supplied with several metal S hooks. A standard hospital bed or plinth 2 ft. in height is placed within the framework.

Suspension Equipment (Fig. 15 (b))

(i) 8 single cotton ropes 6 ft. in length by 1½ ins. in circumference and spliced at one end to a metal ring 1½ ins. by 1½ in. for attachment to the S hooks or suspension springs. Each rope passes twice through a wooden cleat adjuster 6 ins. in length by 1½ ins. and carries in the hight so formed a metal ring and spring clip 3 by 1½ ins. for attachment to the belt. These ropes are used for supporting the limbs.

(ii) 4 double ropes 9 ft. in length by 1½ ins. Each rope has in addition to the ring cleat and spring clip 2 eye pulleys 3½ by 1½ ins. These ropes are especially rigged for use in supporting the pelvis and shoulder regions and are arranged to give a two-to-one advantage when lifting these heavy parts.

Belts The belts are made from 16-oz. 30-in. cupra ammonia treated cotton duck and consist of—

(iii) 8 narrow belts 30 by 6 ins. bound with ½ in. webbing and fitted with a D ring 1½ by 1½ ins. at either end.

(iv) 2 wide belts 3 $\frac{1}{2}$ by 12 ins similarly made but having six D rings 1 at each end and 2 at each side 13 ins from the centre to hold straps across the thorax or pelvis if required, to prevent the belt from slipping

(v) 1 cap-shaped head piece fitted with a D ring at either end

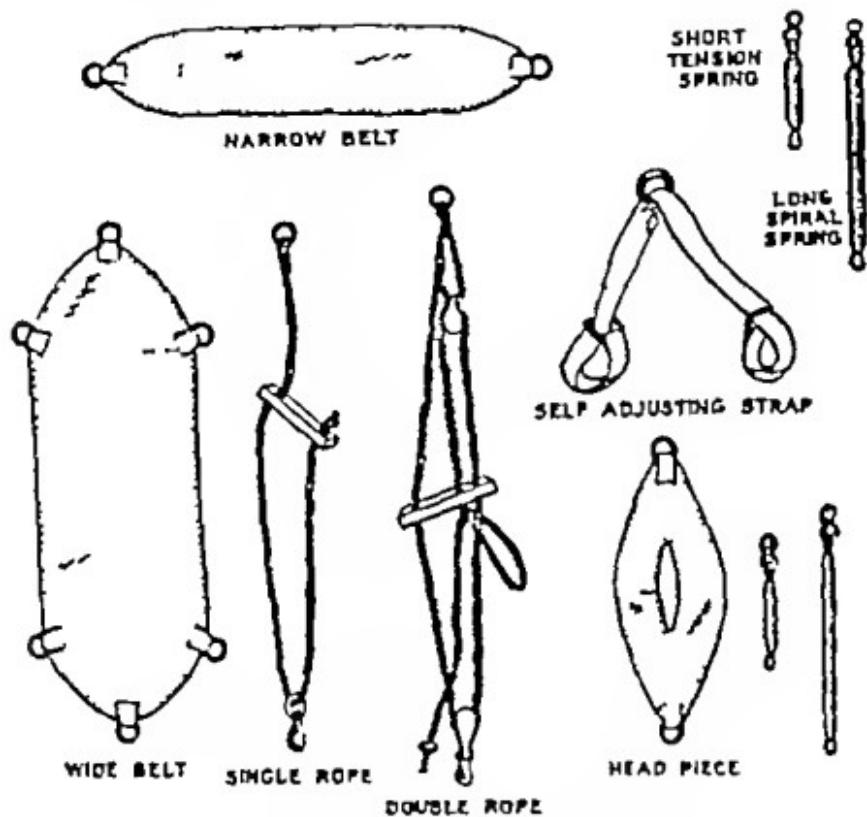


FIG. 15 (b).—Suspension Equipment

The Standard suspension frame can be obtained from the Electro Medical Supply Co., 7777 West Portland Street, W. L. Suspension Equipment, excluding springs, can be obtained from Messrs. A. Gowan & Co. Ltd., makers, West Merton, Lower Rehabilitation Springs from Messrs. H. Terry & Co., 77 Holloway Viaduct, W.C.1. Short Tension Springs from the Alliance Spring & Asterion Co. Ltd., 176 Finsbury Road, N.1.

(vi) 4 self adjusting straps made from 2 in surgical webbing 32 ins in length having a metal ring at each end and carrying a free ring to hold the clip of the suspension rope. These are used for supporting a hand or foot

(vii) Short tension springs. These springs are made from coiled steel and should be obtained in the following sizes

(a) 10 gauge 1 in outside diameter 4 $\frac{1}{2}$ in. body length for supporting the thorax and pelvis

- (b) 13 gauge $\frac{1}{8}$ in outside diameter $4\frac{1}{2}$ in. body length for supporting the thighs and arms and are also used for supporting and resisting head movements
- (c) 14 gauge $\frac{1}{8}$ in. outside diameter $4\frac{1}{2}$ in. body length for supporting the hands and feet.

Note The above body length measurements of the springs do not include the hooks at either end. A minimum of 4 springs of each gauge are required.

(viii) Long spiral springs or rehabilitation springs
These springs are made of fine coiled steel varying from 9 to 12 ins in length and $2\frac{1}{2}$ to $3\frac{1}{2}$ ins in circumference according to their poundage. A series of springs graded in resistances of 10 20 30 40 50 and 60 lb are known as a set. The poundage is calculated by the makers and the springs correspondingly stamped at full tension. A fine cord is fixed within the springs at either end to prevent over-straining but they should never be used at more than half full-extension. A minimum of 2 sets of springs are required.

An S hook $1\frac{1}{2}$ ins by $\frac{1}{8}$ in. inserted into one end of each short tension spring and long spiral spring facilitates connecting the ring of a rope to the spring after it has been hung on the frame.

Modifications of Apparatus

Modifications of the apparatus are legitimate when only a single joint or limb requires treatment. Such modifications must ensure as many as possible of the general principles referred to in subsequent paragraphs. In any case it is essential to secure rigidity and a clearance of at least 6 ft between the points of support and the bed.

Recent experiments have shown that closely linked chains are an efficient and less cumbersome substitute for the ropes, cleats and pulleys.

A hook is attached to the end of the chain passed through the rings on the belt and attached to any link as required to give the correct length.

The chains are most effective when combined with an automatic lifting device such as used with operating tables on which is fixed a suitable couch (*Note* a standard war stretcher makes a suitable top). When these two methods are combined the chains can be adjusted to the correct length after the patient has been raised to the required height, so that, on

lowering the raising mechanism the necessary suspension of limb or the whole patient can be secured.

The special advantages of this method over those described in this chapter are speed of adjustment and ability of one physiotherapist to apply total suspension to a patient of any weight.

3 General Principles

Supported exercises and exercises with resistance are among the oldest forms of movement given to patients and many ingenious apparatuses have been invented to aid recovery of injured limbs.

The G nthrie-Smith method does not lay claim to any fundamentally new principle or require for its adoption any intricate apparatus. The value of this method when compared with other methods is that it is comprehensive and based throughout on sound physical laws. It has reached its present state as a result of long years of clinical trial and can be used with benefit for the single painful joint the extensive paralysis of serious cases of poliomyelitis or the almost rigid spine of the advanced spondylitis.

The general principles of the method are best studied under the following headings:

- (a) Mechanical
- (b) Psychological.

- (c) Relaxational
- (d) Physiological.

(a) Mechanical Advantages

- 1 The ease with which transference of part of the weight of the body or limb under treatment to the overhead supports can be carried out.
- 2 The reduction of the mechanical friction present in every normal movement particularly for bedridden patients.
- 3 The ability to apply the principle of the pendulum the limb representing the weight of the pendulum.
- 4 The facility with which part of a limb can be fixed or provided with increased assistance or resistance.
- 5 The fact that the physiotherapist has an extremely good approach to the part to be treated and never has to take the weight of a limb.
- 6 The fact that a single physiotherapist can lift and control a helpless, heavy patient without further assistance.

Spring and Belt Suspension

Suspension with springs between the supporting point and the belts give certain interesting mechanical advantages thus they can be made to aid or assist any movements or to aid resistance to it also when of correct strength they can give an improved sense of movement owing to the elasticity inherent in any spring that is being operated well within its useful range Again, long springs supporting a limb can be used to set up timed or controlled oscillations which the patient can gradually acquire and keep up by his own volition

Precautions—Springs should not however be used when localised and accurate control of joint movement is desired Nor should they be used in the treatment of fracture unless union is firmly established In these cases simple suspension without springs is definitely indicated.

(b) Psychological Advantages

It is in this field that some of the great advantages of this apparatus are found It gives a sense of security confidence and of something being achieved When the body is fully supported with suitable springs from an apparatus as specified by Mrs G nthrie-Smith the sense of safe buoyancy this gives to the patient has a potent stimulus towards aiding recovery of any lost movements In addition, patients who have a fixed idea that all movement has been lost can in suitable cases be given ocular proof that some movement is actually present As a result they are encouraged to attempt voluntary movements without their previous inhibitions

(c) Relaxational Advantages

It is possible by the appropriate use of sling or spring suspension with correctly adjusted tension and sufficient duration of support to overcome some forms of spasm Spondylitis proves a particularly good example of this aspect of the use of slings as when properly adjusted the rigid kyphosis so dominant in these cases not only tends to diminish but with its diminution range of movement of the spine is increased In cases of spastic paralysis some degree of relaxation of the spasticity is acquired by applying the physiological principle of intermittent stretching carried out in carefully graded rhythm

The spastic muscles tend gradually to accommodate themselves to the increased length demanded of them by this rhythmical movement. This is closely similar to the principles made use of in the training of acrobats. Again an extremely interesting field for relaxation which utilises another important physiological principle is when these suspension slings are used in cases of shell-shock. In these cases the body may be put by the careful adjustment of springs and the use of slings in such a position that practically every muscle of the body has some support. When this has been achieved it is obvious that very small movements can take place with the minimum of resistance. It is obvious that when shell shocked patients can be put into such a position their muscles relax they are thereby in a better physiological state for normal motor unit action potentials to be established. It is probable therefore that a physiological process of this kind explains why these shell shocked patients, notorious bad sleepers sometimes go to sleep while actually under treatment.

(d) Physiological Advantages

From the general principles enunciated under the previous headings it is obvious that the metabolism of the body under suitable suspension treatment can be carried out with greater ease. It is because of this that one of the most remarkable results of the early use of slings in cases of poliomyelitis is found—namely the rapid return of muscle bulk and of tone. In one recent case of poliomyelitis affecting the abdominal muscles the ability to defecate was lost. Recognising that in the act of defecation it was necessary reflexly to contract the abdominal muscles the slings with spring tensions were adjusted to represent this reflex. Defecation was possible as a result and the effect of this undoubtedly aided the speed of recovery to voluntary control.

1 Principles of Application

(a) Simple Suspension without Springs

When treating any part by the suspension method it is essential to use a fundamental starting position in which the suspended part is pivoted exactly over the joint performing the movement. From this balanced position movements can be carried out in this in the arc of a circle in the horizontal plane

Deviation from this starting position is only permissible when it is required to give assistance or resistance to the movement. These points are illustrated by the following examples.

- (i) To obtain a balanced abduction and adduction of the right hip-joint the patient lies on the plinth and the right thigh is supported by a narrow belt and the foot by a self adjusting strap. These are both attached by single ropes to the central cross bar of the apparatus by a hook which must be placed vertically above the hip joint.
- (ii) To assist abduction of the joint the hook is moved outwards.
- (iii) To resist abduction of the joint the hook is moved inwards towards the mid line of the body.

(b) Suspension with Short Tension Springs

Short tension springs are inserted between the hooks and the ropes to act as shock absorbers and to give a sense of buoyancy which is especially valuable in assisting relaxation (e.g. spondylitis). They may also be used to give resistance for short ranges of movement as described in the treatment of scoliosis or for head treatments.

(c) Suspension with Long Spiral Springs

Long spiral springs are also inserted between the hooks and the ropes and may be arranged in the following manner:

- (i) Vertically above the supporting belt, when they are used to set up controlled oscillations.
- (ii) Above and behind the moving part so that the direction of movement and the lines of the spring and rope are continuous. This arrangement gives resistance when the spring is extending and assistance to the movement on the recoil of the spring. It also facilitates the thrusting movements, which are of primary importance in the treatment of recent injuries.
- (iii) Below the moving part by attaching the spring to the low bar of the apparatus. This arrangement is used to give resistance to abduction of the shoulder joint.

Whenever long spiral springs are used it is essential that the poundage of the springs should be selected so that the muscle group in action does not fly back when the spring is contracting or necessitate excessive effort to extend the spring. When the correct poundage is used it will be found that the muscles under treatment can extend the spring and allow it to contract evenly.

(d) Resistance with Springs

It should always be remembered that muscles work best when they work against resistance. This physiological fact can be fully utilised, especially for re-educating legs for their balance tone as a preliminary to walking after a period in bed. When increased resistance is required two springs may be joined side by side (in parallel) in which case the resistance is doubled.

5 CONDITIONS BENEFITED BY SUSPENSION THERAPY

A Orthopaedic Conditions

(a) Recent Injuries

Following recent injuries suspension exercises may be utilised to mobilise the affected joint and to give a series of exercises capable of accurate upgrading to strengthen the associated muscles. The following examples show how the maximum support can be given to the injured part during the early stages of treatment whilst exercises are performed. Progressions are made by introducing resisted exercises against springs and alteration of the starting position.

*Injuries of the knee joint—**Equipment required*

2 narrow belts and ropes
1 small pillow

Methods of suspension —The patient lies on his side so that the injured limb is uppermost. One belt is wrapped round the foot and ankle to form a figure of eight, the other belt supports the thigh just above the knee-joint. Both belts are attached by their ropes to a hook on an overhead cross bar so that the fixed point is vertically above the knee joint. The limb is then raised about 6 ins. from the plinth by manipulating the cleats. To do this the cleat is grasped firmly in the palm of the hand and turned horizontally so that the ropes pass freely through the holes. When the required adjustment of the rope has been made the cleat should be fixed by tilting until it grips the rope. If the ropes are too long they may be shortened at the free end.

hy means of a simple running knot. It is important that the limb should be fully relaxed during the process of suspension. Otherwise it will be found that the maximum support has not been achieved and further unnecessary adjustments of the ropes will be required to distribute the weight. When the limb is in the required position flexion and extension of the knee-joint is performed. During these movements the hip-joint should be steadied against the physiotherapist's thigh. The patient is instructed to swing the lower leg backwards and forwards with emphasis on the backward movement to obtain flexion and a strong kick forward for extension. The physiotherapist can if necessary assist the movement.

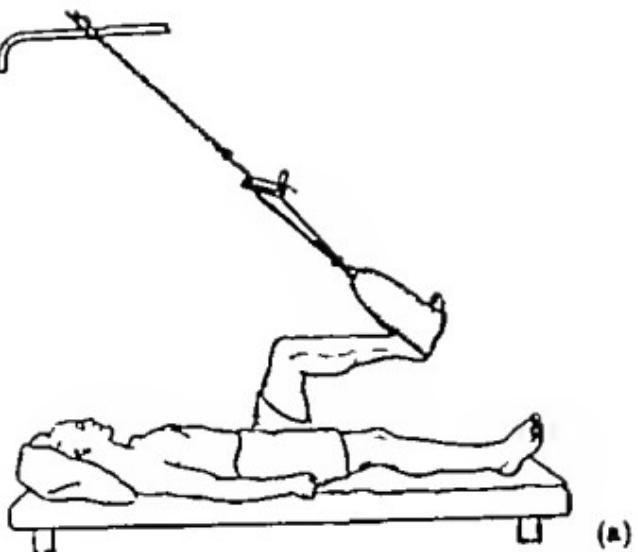
Progressions are obtained by the introduction of spring resistance and alteration of the starting position. One long spiral spring is used (poundage is not specified as it will obviously vary with the muscle power of individual patients).

(i) The patient lies on his back, the foot is supported by a narrow belt and rope fixed vertically. A spring of suitable poundage is attached to the thigh support and the thigh is raised 4 to 6 ins from the couch. The exercise consists of contracting the quadriceps muscles against the resistance of the spring. The foot moves forward as the knee-joint extends.

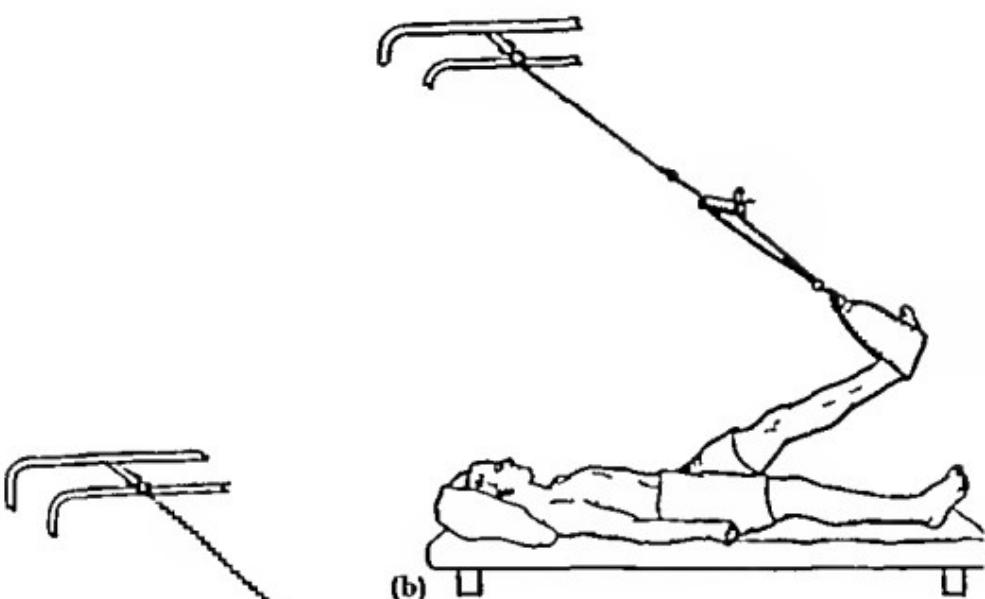
(ii) The thigh support is removed. A spring is attached to the free end of the foot rope and hooked further back to the bar over the head, the knee and hip being flexed to a right angle. The patient is instructed to thrust forwards to extend the knee and downwards with a straight knee to extend the hip (Fig. 16). The limb is then returned to the starting position, the recoil of the spring should be controlled by the patient's muscle power.

(iii) To give resisted exercises for the hamstring muscles the patient lies on his back, with the knee and hip flexed and held in this position by a small pillow against the buttock. The flexed thigh is supported by a belt which is attached by its rope either to the overhead piece or to a fixed hook on the end piece depending upon the angle of flexion required. The foot is supported by a narrow belt rope and spring and fixed vertically. The patient is then instructed to thrust downwards against the resistance of the spring and to control its recoil.

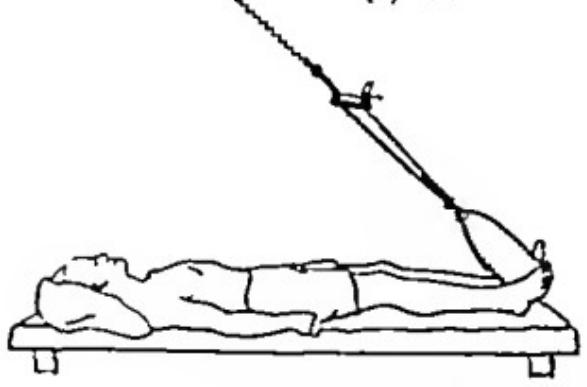
Injuries of the shoulder joint—All movements of the shoulder joint can be assisted by suspension exercises.



(a)



(b)



(c)

FIG. 16.—Injuries of knee-joint.

(a) Starting position for exercise (b) Extension of knee. (c) Extension of hip

Equipment required

- 1 narrow belt and rope
- 1 self-adjusting strap and rope
- 1 long spiral spring

Methods of suspension—(i) To obtain *abduction and adduction* the patient lies supine the belt supports the upper arm. The rope is attached to a hook on an overhead cross bar so that the fixed point is vertically above the shoulder joint, and the ropes are adjusted to give adequate support to the limb. The elbow is flexed and the hand loosely clasps the rope. The patient is then instructed to carry out the required movements.

(ii) *Flexion and extension* The patient sits on the side of the plinth the belt supports the upper arm as for the previous movement. The wrist is supported by a self adjusting strap. Both ropes are fixed to a point above the shoulder joint on the side bar of the overhead unit, and adjusted until the arm is fully abducted or as nearly as possible. The patient is then instructed to swing forwards and backwards whilst the physiotherapist localises the movements by placing one hand over the scapula.

(iii) *Internal and external rotation* The patient lies on his side with the injured limb uppermost if possible the arm is fully abducted and the elbow flexed to 90° the belt supports the forearm just below the elbow the wrist is supported by the strap and the ropes are fixed to a point above the shoulder on an overhead cross bar. The patient is instructed in the required movements which the physiotherapist controls with one hand whilst using the other to fix the scapula (Fig. 17).

(iv) *Elevation, or upward stretching* To obtain elevation the patient remains in side lying but moves forward to the edge of the plinth. The ropes are lowered the elbow is extended and the belt is then placed round the upper arm. The ropes are now fixed to a point above the shoulder joint on the side-bar of the overhead unit and the patient is instructed to swing forwards and upwards. If the shoulder is stiff the movement can be assisted by moving the hook beyond the shoulder towards the head.

Progressions of the various movements possible at the shoulder joint are obtained by the introduction of spring resistance.

(i) *Abduction* The patient sits on a stool or chair at the side of the frame A narrow belt is wrapped round the arm

so that it will not slip and connected to a long spiral spring which in its turn is attached to a hook on the low bar of the frame. The patient holds the elbow in the flexed position and raises the arm to full abduction. The exercise may be pro-

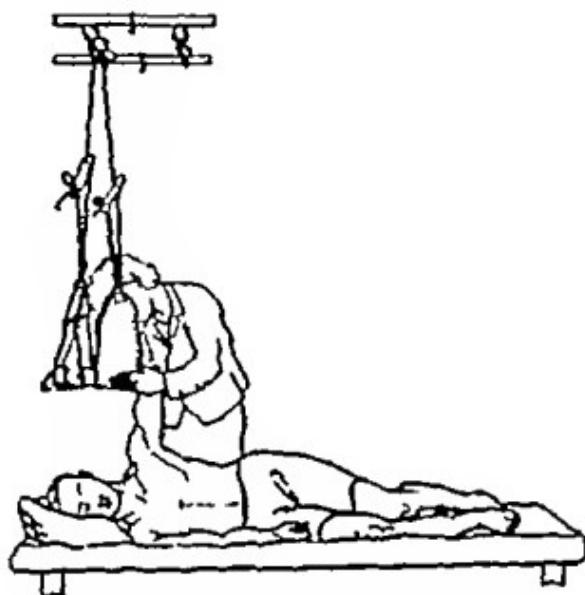


FIG. 1.—Injuries of shoulder joint.

Exercise III External rotation of shoulder

greased by the patient holding the elbow in the extended position

(u) *Adduction* The patient sits in the same position as for abduction. The arm is abducted and the elbow flexed to a right angle. The forearm is supported by a narrow belt connected to a single rope and spiral spring which is attached to a hook on the side bar of the overhead unit. The patient then draws down the arm to the fully adducted position.

(b) *Smith Petersen Nailing for Fractured Femoral Neck*

Post-operative treatment by suspension exercises—

Equipment required

1 narrow belt and rope

1 self-adjusting strap and rope

Before starting treatment on the injured limb the movements should be demonstrated to the patient on the sound limb

Methods of suspension.—(i) The patient lies on his back. A narrow belt is arranged to support the thigh of the injured limb and a self adjusting strap supports the foot and ankle. Belt and strap are then connected to their ropes which are both fixed to a hook on the central cross bar so that they are pivoted above the hip-joint. The ropes are then adjusted until the limb is raised about 4 inches from the bed. The sound limb is placed in abduction in order to fix the pelvis. The patient is instructed in equal movements of abduction and adduction of the hip-joint.

During the first treatment the range of movement should be small gradually progressing to a wider range of movement at subsequent treatments as the muscle power improves.

(ii) The patient lies on his side with the injured limb uppermost. The thigh and foot supports are again pivoted over the hip-joint and active flexion and extension of the hip are performed whilst the physiotherapist supports the lumbar spine with the front of her thigh.

(iii) Exercises as given for the knee joint (page 115) are also necessary when treating patients after Smith Petersen Nailing of the hip.

N.B.—A modified apparatus may be used for Exercises

(i), (ii) and (iii) while the patient is in bed. The standard frame is necessary for Exercise (iv) below.

Progression.—(iv) Long spiral springs can be used at a later stage when union is firm.

Equipment required

- 4 narrow belts and ropes
- 2 self adjusting straps and ropes.
- 1 wide belt and 2 double ropes.
- 2 long spiral springs

The patient lies on the plinth. Both legs are supported as for abduction and adduction of the hip joint (page 114) and the ropes are then attached to hooks on the central cross bar. In addition the pelvis is slightly raised by means of a wide belt connected to the double ropes which are attached to the side bars of the overhead unit. A narrow belt is now placed round the sole of each foot and connected to a spiral spring and single rope. Both ropes are passed backwards in a straight line and knotted to the lower transverse bar of the end unit. The patient

then thrusts alternately against the resistance of the springs (Fig 18). This exercise will enable the patient to walk without humping when the weight bearing is commenced.

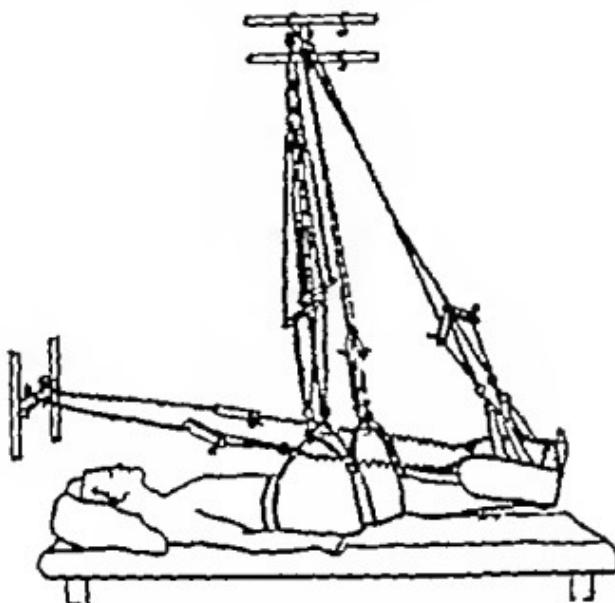


FIG. 18.—Smith Petersen nailing of the hip
Exercise IV. Thrusting movement for re-education of walking

(c) Sacro-iliac Strain

The aims of treatment are to obtain relaxation of the muscles which are in a state of tension. When relaxation has been attained, the slings are used to secure mobilisation and improvement of muscle power.

Equipment required

- 1 narrow belt and rope
- 2 wide belts, 3 double ropes
- 1 self-adjusting strap and rope

Methods of suspension—(i) The patient lies on his side with the injured joint uppermost. The narrow belt supports the thigh; the foot is supported by the self-adjusting strap. Both ropes are attached to a hook on an overhead cross-bar so that the point of suspension is over the sacro-iliac joint. The limb is raised until it lies in the same plane as the joint. The patient clasps the flexed knee of the sound side to fix the pelvis and is encouraged to relax the supported leg completely so that the

slings take the full weight of the limb. The physiotherapist can test the degree of relaxation by gently swinging the limb. It may require a whole treatment before full relaxation is secured.

(ii) The patient lies on his side. Both thighs are supported by one wide belt and double rope; both feet are supported together by a narrow belt and rope. Both ropes are then fixed to a point above the sacro-iliac joint on an overhead cross bar so that the limb on the injured side is in the same plane as its joint. The physiotherapist supports the sacro-iliac joint with one hand and with the other gently swings the lower limbs backwards and forwards in a gradually increasing range of movement. This should be followed by active swinging movements by the patient.

(iii) The patient remains in side lying and the knees are flexed. The supports for the lower limbs and the point of fixation are the same as for Exercise (ii). In addition a wide belt is placed under the pelvis and connected by two double ropes to books on the side-bars of the overhead unit. The ropes are adjusted so that the pelvis is raised about 2 inches from the plinth. The physiotherapist places one hand on the dorsal region and the other on the back of the thighs and swings the legs forward until the knees touch the chest. The hands are then changed to the front of the knees and chest and the legs are swung backwards until full extension of the lumbar spine is obtained.

(iv) The patient lies on the back with the knees and hips flexed to a right angle. The supports for the pelvis and lower limbs are the same as for Exercise (ii). To accommodate the new starting position the thigh belt is placed just below the knees. The patient fixes the thorax by grasping the bars of the end unit and is instructed to swing both legs alternately from side to side so that the maximum movement takes place at the lumbar spine (Fig. 19). Assistance may if necessary be given by the physiotherapist.

Note. In the treatment of scoliosis and kyphosis by suspension the apparatus is adjusted so that the body weight acts as the corrective force of the deformity. This method of applying the corrective strain has the advantage that it can be sustained for longer periods than any other form of remedial exercises.

(d) *Scoliosis*

The aim of treatment is correction of the primary curve i.e. to the area of greatest convexity. If a primary curve convex to

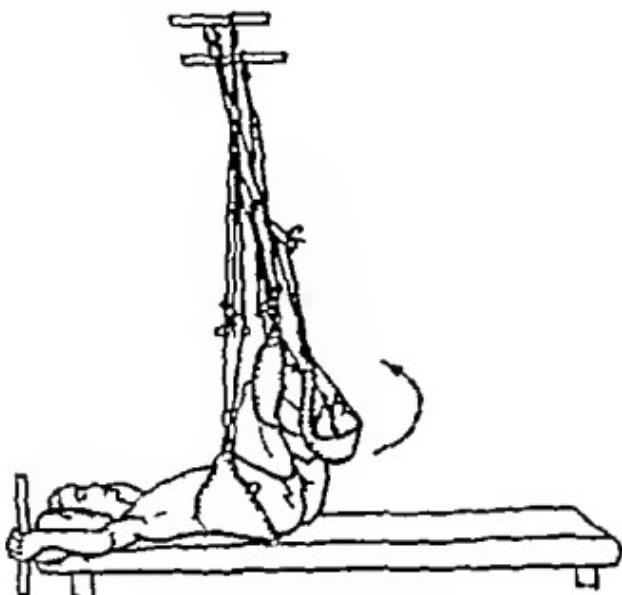


FIG. 10.—*Sacro Iliac Strain.*

Exercise IV. Pelvis swing to right.

the right in the dorsal region is taken as an example suspension should be carried out as follows

Equipment required

- Head piece 2 single ropes
- 1 narrow belt 2 double ropes
- 2 narrow belts 2 single ropes.
- 1 wide belt 2 double ropes
- 2 No 10 gauge ten ion springs
- 2 No 13 gauge tension springs
- 1 small pillow

Method of suspension—The head piece is suspended in position the narrow belt attached to the two double ropes is arranged to support the dorsal region the wide belt attached to the double ropes and No 10 gauge tension springs supports the pelvis. The two narrow belts connected to the single ropes and No 13 gauge tension springs are both hooked to the central point of the central cross bar. These support the legs one belt

is placed above the knees and the other above the ankles. The patient lies on his right side on the plinth and the head rests in the head piece. The chest is slightly rotated to the left so that the pressure from the dorsal belt is concentrated on the angle of the ribs. A small pillow placed under the area localises the point of correction. The ropes are then adjusted until the body is raised approximately 2 ins from the plinth. The dorsal belt is then raised further in an attempt to over-correct the con-

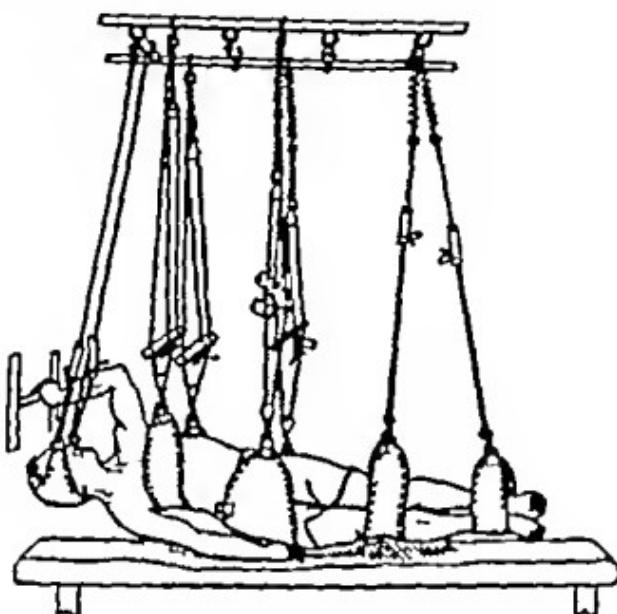


FIG. 20.—Scoliosis. Correction of primary curve of right dorsal region.

vexity deformity finally the front rope is raised sufficiently to minimise the rotation deformity (Fig. 20). The position should be maintained for 5 minutes at the first treatment and the time gradually increased. The patient should also perform side flexions against the resistance of the springs whilst in the corrected position.

(e) Kyphosis

Equipment required

2 narrow belts and ropes.

1 pillow

Method of suspension—The patient lies on the plinth in the prone position with his hands clasped under his forehead the pillow being placed under the pelvis and lower abdomen. The

upper arms are supported by the belts the ropes of which are suspended to the central point of the cross bar over the head. Occasionally it may also be necessary to support the chest. The head is now actively supported by the clasped hands. The ropes are then raised sufficiently to allow the front of the chest to clear the plinth aiming at a correction of the deformity. The position should be maintained for 5 minutes at the first treatment and the time gradually increased. The following exercises are performed in the corrected position.

- (1) Head raising with back arching
- (2) Double arm backward pressing
- (3) Localised mobilising exercises e.g. alternate side flexion
the physiotherapist should indicate the point of flexion by firm pressure with the outspread thumb and index finger

B Rheumatic Conditions

(a) Non-articular Cases

Lumbago—Suspension exercises may be used with advantage in the later treatment of lumbago to mobilise the lumbar spine and obtain strong muscular contractions.

Equipment required

- 2 narrow belts and ropes
- 2 wide belts 3 double ropes
- 1 self-adjusting strap and rope

Method of suspension—(i) The patient is suspended as for sacro iliac strain Exercise (iii) (page 122) but with the knees extended. The patient grasps the side of the plinth with the uppermost hand and the head rests on the lower forearm. This fixes the thorax. The physiotherapist then places her thigh against the lumbar region and both hands across the abdomen to localise the movement while the patient swings both legs backwards and forwards in a widening arc until the limit of flexion and extension is obtained.

(ii) The patient lies on his back with the knees extended. The legs and pelvis are raised until they are just clear of the plinth the supports being the same as for the previous exercise and the thorax is fixed by grasping the end unit. The physiotherapist places one hand on either side of the lumbar region to localise the movement and the patient swings both legs alternately from side to side.

(iii) The patient lies in the prone position. The thorax is supported by a wide belt attached by two donhlo ropes to hooks on the side bars of the overhead unit so that the effective point of suspension is over the lumbar region. The ropes are then adjusted until the thorax is raised 4 ins from the plinth. The upper arms are supported by two narrow belts the ropes of which are suspended from the central point of the overhead cross bar. The head is supported on the clasped hands and the patient then swings the trunk in an alternate side bending.

(b) *Articular Cases*

(i) *Spondylitis*—In the treatment of spondylitis by suspension methods the primary aim is to obtain relaxation this is followed by an attempted correction of the deformity by gentle mobilisation particularly of the costo vertebral joint and improvement of the muscle tone. It is important that these aims should be explained to the patient before treatment is started and his active co-operation gained. It is essential that the patient should be warmly but lightly clad as relaxation makes a patient cold. The body should be totally suspended but no attempt at correction of the deformity should be made.

Total body suspension—

Equipment required

Head piece 2 single ropes
4 narrow belts 4 single ropes
2 self-adjusting straps 2 single ropes.
2 wide belts 4 double ropes
4 No 10 gauge short tension springs
6 No 13 gauge short tension springs
2 No 14 gauge short tension springs

One narrow belt is used for each arm and thigh respectively the self adjusting straps support the feet. The wide belts support the chest and pelvis and the head rests in the head piece. The No 13 gauge short tension springs are used with the head arm and leg supports the No 10 gauge with the chest and pelvis supports and the No 14 gauge with the self adjusting foot straps.

Method of suspension—The belts are placed in the required position on the plinth and the ropes and springs are connected to the overhead hooks. The patient lies on the plinth with the

arms supinated the belts and ropes are connected and the self adjusting foot straps are applied. The body is then raised sufficiently to clear the plinth the ropes being adjusted in the following sequence Head arms chest pelvis legs (Fig. 15)

If the patient has much pain or discomfort as a result of his disability the above process should be carried out in two parts During the first part the ropes are adjusted in the above sequence so that the body weight is still partly supported by the plinth it is then possible to repeat the process and obtain total suspension The patient should now be encouraged to relax completely allowing the supports to take the full weight of the body He should also close his eyes and breathe deeply and quietly with long expirations The physiotherapist can assist relaxation by talking quietly to the patient whilst performing rhythmical strokings of the limbs

The suspended position should be maintained for half an hour morning and afternoon increasing rapidly to one and a half hours morning and afternoon. As soon as the patient has accustomed himself to the treatment an attempt should be made at correcting the deformity by slightly raising the belt supporting the dorsal region Eventually the whole period of suspension should be spent in the corrected position

The following active and resisted spring exercises should be performed about half way through the period of suspension and again at the end

- (i) Head extension.
- (ii) Double arm extension with deep breathing
- (iii) Double leg abduction and adduction.
- (iv) Attempted back arching

(u) *Chronic arthritis*—The use of suspension methods with springs are of great value in enabling patients suffering from chronic infective arthritis to regain the sense of movement which in many cases has become almost completely lost Stiff joints can be mobilised and weak muscles re-educated without undue fatigue Both types of spring should be used in the treatment of these cases

To regain the sense of movement the patient should if possible be totally suspended, using short tension springs as described in the treatment of spondylitis (page 126) In addition, both wrists should be supported by self adjusting straps with springs The patient should then be encouraged to move

both arms or both legs in small co-ordinated movements. The limbs with the greater range should be moved first followed by the others and finally all four together. When the patient has gained confidence and has seen that it is possible to perform movements he may be suspended for increasingly long periods and left to carry out movements for himself. This method has great psychological value as it gives the patient a realisation of possible independence which no movement of a single limb is capable of doing and so spurs him on to further effort. The length of time that the patient can be suspended will depend upon the pain factor and the degree of disability. When in patient treatment is available and adequate rest is assured, one period of the day may be given to suspension as described and a second period devoted to mobilisation and re-education with long spiral springs. When an Out patients department is being attended the possibility of over fatigue must be constantly borne in mind and it may be wiser to give total suspension on one day and mobilisation with the spiral springs at the next attendance. When the long spiral springs are incorporated for the mobilisation of arthritic joints full use is made of the oscillations which can be set up and maintained by the patient. The technique described in the following examples can be applied to the treatment of single and multiple joints.

Mobilisation of hips—

Apparatus required

2 narrow belts and ropes

2 spiral springs

Method of suspension—The patient lies on his back one leg is treated first. A belt is wrapped round the foot and ankle to form a figure-of-eight and the other belt supports the thigh. These are connected to their ropes and springs and attached to hooks so that they are suspended vertically. If the movements are very limited the physiotherapist sets up small oscillations in the springs by gentle intermittent pressure and relaxation on the thigh and lower leg and encourages the patient to take over the movement. He should then be instructed to time his muscle contractions to correspond to the extension of the spring and to relax with the recoil. When this is attained an effort should be made to increase the range of movement (Fig. 21). These oscillatory movements can then be utilised to obtain

abduction and adduction of the hip. When the other leg has been similarly treated progressions can be made by performing co-ordinated movements of both legs. These can be followed by fixing both legs together by a double belt at the thigh and a single belt round the feet. Stronger springs are inserted to

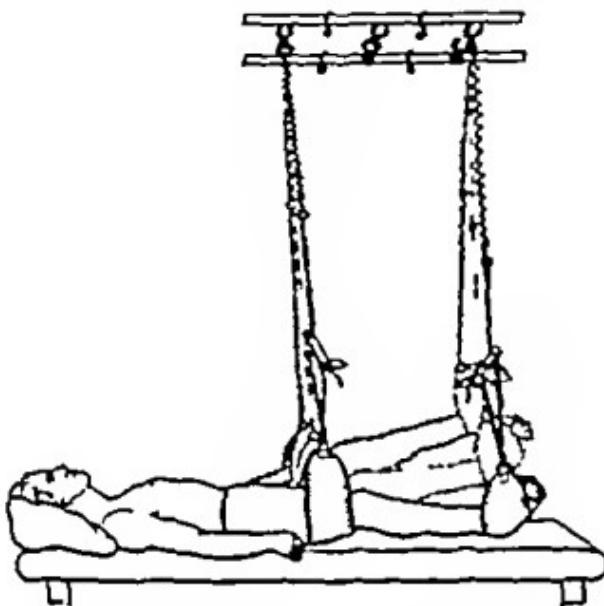


FIG. 21.—Mobilisation of an arthritic hip. Increasing range of movement obtained by spring oscillation.

take the additional weight. Exercise (iv) for Smith Petersen Walking (page 120) is also useful.

Mobilisation of shoulders—

Apparatus required

- 2 narrow belts and ropes
- 2 spiral springs

Method of suspension—The patient sits sideways on the plinth the elbows are flexed and both upper arms are supported by the belt, which are connected to the ropes and springs and attached vertically to the side bar of the overhead unit. Oscillating movements are set up and maintained by the patient as previously described. This method can be used even when there is very limited abduction and is especially useful as a double-sided movement. But unless special care is taken especially when the degree of abduction is small the slings may slip. This tendency to slip may be avoided either by wrapping

the sling round the elbow in a figure of eight or by fixing with a small piece of elastoplast

C Nerve Conditions

(a) *Flaccid Paralysis*

The re-education of movement by the suspension method necessitates a precise technique so that the first sign of active movement can be recognised and assessed. Considerable skill is required in the fine grading of progressive exercise when voluntary movement has been established.

The aims and method of treatment should be carefully explained to the patient so that he understands what is required of him and his full co-operation sustained over the long period which is necessary to obtain results. The following example may be applied to the treatment of any paralysed muscle.

Treatment of a paralysed deltoid—

Apparatus required

1 narrow belt and rope

Method of suspension—The patient should lie on his back. The upper arm is supported by the narrow belt which is placed just above the elbow joint and attached by its rope to a hook on an overhead cross bar so that the fixed point is vertically above the shoulder joint. The elbow is flexed and the hand loosely clasps the rope. The rest of the body should be completely relaxed and the limb under treatment kept warm by means of a radiant-heat lamp. The physiotherapist should then carry out the following tests to assess whether any voluntary movement is present and if so its range and power.

To assess movement—The patient remains relaxed whilst the physiotherapist sets up a pendulum swinging movement of the limb which covers approximately half the normal arc of an intact deltoid. She then leaves the limb alone and the number of gradually diminishing arcs of movement before it comes to rest are counted. The same process is repeated but this time the patient assists the swing as much as possible but not exceeding the original arc of the swing. An increased number of swings before the limb comes to rest or a maintained swing will prove that voluntary movement is present. This is checked

by instructing the patient to abduct the arm from 45° to 90° by a single swing. The range of active movement is assessed by placing a board marked out as a measure under the arm and the patient swings as far as possible into abduction. When carrying out this test care should be taken that a false range is not given by the patient adducting the arm and thus obtaining a correspondingly greater swing back. Finally the power of the muscle is assessed by giving manual resistance to abduction. The first two tests should be charted and records kept at weekly intervals.

Treatment—If movement is absent or very feeble the position of the hook is altered so that it is slightly behind the shoulder joint and assistance is thus given to the attempted movement. When the patient is unable to produce a voluntary contraction the physiotherapist gently swings the arm into abduction from near the mid line whilst the patient concentrates on trying to assist the movement. Then the arm is returned to the starting position and the process is repeated. Repetition of this one way movement will encourage correct innervation the rhythm will assist returning muscle power. During the process the physiotherapist places her free hand lightly over the deltoid so that the faintest muscle contracture can be detected. When a contraction is felt for the first time no immediate attempt is made to repeat the effort. Once the impulse returns the patient should try to time the contraction so that it is made just as the arm is swung upwards from 45° abduction. In this position the muscle is at its strongest leverage. Great care must be taken that the muscle is not over fatigued with a consequent weakening of the impulses and the danger of producing trick movements. Kneading and fine vibratory movements are given between the exercises to give rest and relaxation.

Progression is made by altering the position of the hook so that the point of suspension is vertically over the shoulder joint. An effort should be made to increase the range of movement and to arrest the movement at a word of command. This latter exercise is particularly difficult for a paralysed muscle and patients cannot do it at once but only after a fraction of time or latent period. A shortening of this latent period is a very good sign of progress. The swinging movement may be made purposeful in character by swinging the arm against

a tambourine to make a beat. This prevents the exercise from becoming an automatic action of an aimless character. Resistance is given to these exercises by again altering the position of the hook so that it is slightly in front of the shoulder joint. Further progressions are made by introducing spring resistance and finally manual resistance.

(h) *Spastic Paralysis*

In the treatment of spastic paralysis the chief aims are to obtain relaxation and co-ordination of movement and maximum strength in any muscles that are liable to over-stretching by the contraction of their antagonists. Relaxation is the primary objective and much time and care is necessary to produce the maximum result. Except in cases where one limb only is involved, total suspension is usually found to be the most satisfactory method of suspension.

Equipment required

As for total suspension (page 126)

Method of suspension — The body is supported by total suspension with or without springs according to individual needs. With these cases the limbs should be suspended at their centre of gravity. For the arms these points lie just above the elbow (with the forearm supinated) for the legs at the upper margin of the knee. The knees should be very slightly flexed and the feet supported. Relaxation is then encouraged as previously described (page 127) and the process must be un hurried. These patients should if possible be treated so that outside disturbances do not cause a sudden increase of spasm. For the exercises which follow relaxation the hooks should be readjusted so that the points of suspension are over the joints performing the movement.

Exercises — The patient is instructed in double-sided co-ordinating exercises aiming at smooth rhythmical and large-range movements such as double leg abduction. These can be assisted by the use of music or counting. Movements of the upper or lower limb should be attempted first followed by movements of all four limbs.

Progressions are made by variations and complications such as the simultaneous adduction of one arm or leg and abduction of the other or in suitable cases the legs and arms can work

together or carry out different actions to command. These exercises are preliminary to Frankel's Exercises as they are easier and less fatiguing for the patient to perform.

When re-education of the extensor muscles is required as in hemiplegia the one way movement method should be adopted. The patient endeavours actively to extend the limb and allows it to be returned to the starting position by the swing back of the ropes.

CHAPTER 8

IN COMPLICATIONS FOLLOWING TRAUMA

THE great majority of the difficulties and complications encountered by physiotherapists are the result of injury. Cases of excessive oedema associated with a quite ordinary sprain are common so also are cases of long persisting residual pain after some simple fracture. After operation on a cartilage a number of patients exhibit loss of voluntary power in their quadriceps—a condition familiar to every orthopaedic surgeon.

The complications may be considered under the following heads

- 1 (A) Oedema
(B) Chronic thickening.
- 2 Persistent post-traumatic pain.
- 3 (A) Muscular inhibition.
(B) Lax joints
- 4 Delayed union
- 5 Myositis ossificans
- 6 Pressure palsies (crutch operation table and burying)

1 (A) OEDEMA

Serious oedema, not uncommon in fractures may also occur in a number of other conditions such as burns frostbite, immersion foot and sepsis. In the hands oedema is a special danger and the importance of its early and efficient treatment has been dealt with in Chapter 5.

It is now universally accepted that the sooner oedema is actively treated the better the chance of complete recovery. If there is delay fibrous tissue is rapidly formed with all its inherent tendency to organisation and contraction.

Treatment of Post-traumatic Oedema

Experience is pointing to three methods as those chiefly of value in the treatment of post-traumatic oedema. These are (a) gravity (b) cooling (c) making use of electro-osmosis.

(a) *Gravity*—The value of gravity in conditions of oedema has been known and made use of in medicine probably from time immemorial. The only difference in modern practice is to make sure that the value of gravity is fully utilised by adequate suspension for continuous periods.

Physical therapy treatments must as far as possible adapt themselves to this primo need of an oedematous part.

(b) *Cooling*—Recent work in Canada and the U.S.A. has shown that animals that have been subject to a standard shock by bleeding show a mortality percentage which varies as follows with the temperature to which they are exposed:

(i) 52° F	38 per cent
(ii) 72° F	18
(iii) 80° F	45
(iv) 95° F	93

From these figures it will be seen that 72° Fahrenheit in temperate climates is probably the best temperature for parts under the handicap of serious injury. This temperature can usually be reached by the use of a simple silent running cooling fan. A pattern of a fan of this description evolved as a result of direct war experience has been produced in the Electro-Medical Research Laboratory of the R.A.F.

(c) *Electro-osmosis*—This effect can be produced by the use of a direct current of zero frequency or as it is usually known among physiotherapists stable anodal galvanism. The electro-osmotic action takes place on fluids that are capable of carrying the current and the fluid of oedematous parts is particularly susceptible to this action. Mr Barron utilises this effect at the same time as gravity. This current however can be employed in all conditions where there has been lymphatic effusion into the tissues which it is desired to reduce. There is never any danger or adverse effect with this current though in certain cases it is liable to be less effective than in others. It is not necessary to include the actual injured part under the active electrode and pad. It is sufficient if this is placed distally utilising the positive pole and a small current not exceeding 1 to 2 m.a. Treatment should be given for from 15 to 20 minutes and may in acute cases be repeated 2 to 3 times in the 24 hours. The negative electrode can be placed on any other part of the body provided that the direction of the flow of current from

positive to negative and that of the lymphatic stream are the same

1 (B) Chronic Thickening

Chronic thickening in tissues following any of the above conditions means essentially that the early efforts to clear the tissues from their oedematous condition have been anyway in part unsuccessful. Fibroblasts have made their appearance and fibrous tissue is active with all its potential tendency towards adhesions and contractions

Treatment of Chronic Thickening

Gravity cooling and direct current are no longer of value and the tissues now require increased blood supply they also require movements of a type that prevents contractions but does not irritate the tissues to make further fibrous tissue In these cases exposing the part directly to radiant-heat or infra red is liable to cause acceleration of the process of contraction rather than amelioration as the tissues are put under the necessity of converting the shorter infra red rays to the longer ones that are their usual environment The interposition of lint or towelling tends to absorb the direct heat rays and convert them so that the envelope of air under the lint carries warmth to the limb by conduction and convection Tissues with recently formed or forming fibrous tissue should therefore never be exposed to direct radiation of this kind but only to the longer infra red rays by inserting towels or similar material between the source and the injured part The heat given off by paraffin wax is essentially of the long infra red type and it is probably this fact that makes the wax bath so valuable in this type of case The technical details for the use of paraffin wax in band injuries are given on page 169

Active Movements

The rules for active movement (not stretching) of parts with post-oedematous chronic thickening are as follows

- (1) Free active movements must be performed at frequent and regular intervals each day i.e. at least 5 minutes of every hour
- (2) The movements must include the full range of all the joints distal and immediately proximal to the area where the chronic thickening is situated.

- (3) General exercises for the body must be given, as the affected part is essentially a part of the whole
- (4) Movements by means of remedial occupation should be introduced as soon as possible in addition to these exercises to regain the functional use of the part involved

Surging Sinusoidal Current

The surging sinusoidal current has a field of some utility here. The late Dr Cumberbatch obtained impressive results especially in the then common thickened and stiff wrists following Colles fracture by immersing the arm in an arm bath and adjusting both electrodes in the same bath so that at the maximum of the surge the contracting muscles put a pull on the fibrous tissue. This type of treatment requires careful introduction and grading and should be done daily over a long period. It fell out of favour when the Böhler technique was introduced. It is however beginning to be used again by orthopaedic surgeons and is well worthy of a trial in suitable cases in association with voluntary movement.

Summary

To sum up. The physical treatment for oedema and thickening is support so as to ensure adequate gravity drainage cooling to approximately 72° F utilisation of the direct current active movement and stretching of parts affected by oedema under the rules given above and avoidance at all stages of direct irradiation by either radiant heat or infra red.

2. PERSISTENT POST TRAUMATIC PAIN

There are two types of this condition that may be recognised one with what may be called a rheumatic underlay with all the implications of this condition such as toxins gout the menopause. The other is mechanical and divides itself into the purely mechanical adhesions and neuromata.

Rheumatism and Persistent Pain

It is the practitioner's duty to discover estimate and direct physical treatment towards any underlying rheumatic condi-

tron. However it cannot be repeated too often that failure to obtain as completely satisfactory a result in orthopaedics as the condition should yield is due in a large number of cases not to any lack of surgical skill but to failure to take into account the existence of some rheumatic or other manifestation.

It is frequently most gratifying to find that by active treatment of an underlying or basic menopausal rheumatism, pain and residual limitation of movement following an injury are rapidly resolved.

All orthopaedic cases therefore where progress is abnormally slow in yielding to treatment should be brought under review.

It is too much of a counsel of perfection to advocate a full and careful overhaul of every patient even with a minor injury. But if not this then the nearest approach to it should be made by putting a full overhaul into action as soon as any patient shows a tendency to delay in recovery beyond a good average. It is therefore the physiotherapist's duty to be active and early in drawing the practitioner's attention to any apparent delay in normal recovery.

Mechanical Causes of Post-traumatic Pain

The purely mechanical causes of post-traumatic pain are the special care of the surgeon and are largely due to mal alignment as the result of the injury. It is occasionally possible to minimise this type of pain by strengthening other groups of muscles by the intensive utilisation of faradism and active exercises.

Adhesions

In this category physiotherapy has a valuable and active field. The reduction or elimination of adhesions is achieved differently according to whether they are present in tendons, muscles or joints. Adhesions in tendons are best treated by chlorine ionisation carefully localised to the area of the tendons followed by or alternated with, paraffin wax baths (page 109). Adhesions in muscles yield best to short-wave followed immediately by active exercises. In joint adhesions intermittent passive congestion followed by vigorous active exercises and the joint then put in a wax bandage for 12 to 24 hours according

to the type which still allows the patient to do frequent voluntary movement will be found to yield the best results

When giving exercises for adhesions it must be remembered that joint mobility is useless unless it is governed by efficient muscular control without this there will be a recurring effusion and instability of the joint

The rules for active movements and for stretching adhesions are as follows

1 All passive stretching of the part by the physiotherapist is contra indicated as it only leads to further adhesions

2 Active movements should be carefully graded, through static contractions to free active and resisted exercises

3 Grading of the exercise applies to both the amount of muscle power expended on any one exercise and the time allowed for the exercise session. This is especially important when giving resisted movements if continued too long there will be a reaction in the tissues and a decrease of movement

4 Exercises should be performed at regular and frequent intervals throughout each day

5 General exercises should be given in addition to exercises for the local condition so that the patient's attention is not fixed continually on the affected part These should be in the form of group activity in competition with other patients

6 Remedial occupation should form part of the exercise period of each day

7 The number of degrees of movement gained should be accurately recorded at weekly intervals

Neuramata

Painful amputation stumps are a source of great discomfort however skilful the surgical procedure may have been There is however one electro medical treatment that is occasionally of great value sometimes producing most dramatic relief.

Apparatus required

1 source of faradic stimulation without a condenser in the primary—a direct-current apparatus

1 steel needle coated with celluloid dissolved in acetone the tip being exposed for 1 millimetre and the eye freed from the non-conducting celluloid coating

1 suitable handle for holding the needle

A small chamois-leather-covered searching electrode, about the size of the head of a hat-pin

Accessories for an indifferent electrode and for marking the skin.

Method.—The painful area is damped with warm saline a searching electrode attached to the faradio apparatus is deployed over the surface at a current strength just above the threshold of perception. If a strictly localised area, whether on the scar line or off it is found that produces discomfort akin to the type of pain the patient complains of this is accurately marked on the skin surface the search is then continued and all such areas marked.

With suitable antiseptic precautions and a small drop of intra-cuticular anaesthetic if desired, the steel needle attached to the negative of the source of direct current is inserted and moved about at suitable depth until a point is found that produces the pain or part of it from which the patient suffers. During this search a current of $\frac{1}{2}$ to 1 m.s should be running. On reaching a true pain producing spot the greatest care is taken not to move from it. The current is then increased to 3 m.s for 2 minutes and then reduced to zero and the needle withdrawn. It is important to note that diffuse spots do not yield well to this treatment and that it is necessary to treat all true spots before real relief of pain is secured.

Although this treatment is beyond the field of the physio-therapist she has an important role to play as assistant

3. (A) MUSCULAR INHIBITION

Muscular inhibition following an operation is an interesting condition and the exact pathology of it is not yet known. The best example is found after operation for removal of a cartilage of the knee. In an appreciable percentage of these cases the patient is completely unable to make even the feeblest voluntary contraction of the quadriceps extensor. This condition may persist so long that when voluntary control of muscular contraction returns the knee joint is abnormally stiff and limited in movement. In consequence disability time is greatly prolonged.

A number of techniques have been tried the majority proving of little value. A combination of short-wave and sus-

pension therapy is however of definite value in accelerating recovery and preventing knee stiffness in the absence of voluntary control

Apparatus required

Short wave with pads

A suspension frame

Method—Short-wave therapy should be instituted from the day the absence of voluntary control over the quadriceps extensor is first observed. One pad is placed over the lower six dorsal vertebrae and the other over the dressings and bandages on the knee (*Note*. If metal has been inserted during the operation either as wire or sutures the thigh pad is placed on the anterior aspect of the knee just above the operation site) The current should be continued until a sensation of warmth is felt at first half way and later right up the thigh. It should be given daily until voluntary control has returned when the methods given for lax joints should be used. The methods to be employed when using the suspension therapy apparatus are given in Chapter 7 (page 115 and Fig. 16). The great value of the suspension therapy apparatus in this condition is that the spring is a potent method of suggesting to the patient movement of the affected muscle group.

3 (B) Lax Joints

Lack of tone following injury or debility can be materially assisted toward complete recovery by the addition of electrical treatments to the routine voluntary exercises carried out frequently and regularly by the patient

Apparatus required

A combined treatment table with both surging sinusoidal and surging faradism available

A Morton Smart or Smart Bristow Coil

Specially cut electrodes for the joint to be treated and the usual accessories

Method—A toneless knee following a slipped cartilage which has recovered from the immediate injury but feels weak may be taken as an example

(a) An electrode about 9 ins long kidney-shaped and covered with 2 thicknesses only of lint which has been soaked in warm saline, is bandaged on just below the patella

with the horns of the kidney pointing upwards. Another electrode about 15 to 18 ins long and 3 ins broad also covered with 2 thicknesses of lint and soaked in saline is applied round the junction of the upper and middle third of the thigh and bandaged firmly into position, and the free ends of the flex from these two electrodes are connected to a source of surging sinusoidal current.

At the initial treatment the strength of current with the patient half lying and the knee slightly flexed over a pillow should be sufficient to produce visible contraction of all the thigh muscles without any sensation of cramp or lifting the foot off the couch.

Treatment by this technique once or even twice daily for a week to a fortnight according to the degree of laxity will produce improved tone in all the muscles passing over the knee joint. At the end of this time it may be necessary to give individual stimulation to the muscles and for this the technique recommended by Sir Morton Smart is the best.

(b) *Morton Smart technique*—This technique is a highly developed, specialised electrical re-education or rehabilitation of muscles by carefully graded multiple stimuli of their motor points using a form of faradic current that has been developed to smooth out excessive voltage peaks. As applied by operators specially trained in this technique the treatment yields remarkably good results in cases of weak and painful muscles.

Commentary

This treatment is of particular value in recurrent dislocations of the smaller joints which are not of too old standing.

A guide to the probable success of this treatment is greater comfort for longer periods after each session until the increased one lasts the whole interval between treatments. If there is increased discomfort even after the first session the treatment must not be repeated without further medical advice.

4 DELAYED UNION

In delayed union or non union of bones following a fracture it is obvious that electrical treatment cannot help if the cause is closed sepsis or the interposition of muscles or other structures.

between the broken ends. If however the bones are in reasonable apposition and adequately immobilised and if the processes of repair are merely sluggish then electrical currents can help and their use should be controlled at regular intervals by X rays.

Apparatus required

- (a) A combined table providing both direct current and surging sinusoidal.
- (b) A portable ultra-violet light lamp with a minimal erythema dose time of not less than 2 minutes at 26 ins.

Methods—(a) The negative effects of the direct current are required with as strong a current as the condition of the skin will allow. This in effect is a form of counter irritation. In addition to this counter irritation the negative pole is feeding in directly to the site of the injury negative electrons in the greatest concentration the conditions will permit.

Taking as an example a case of delayed union in the middle shaft of the femur the whole thigh is encircled by a large pad of at least 12 thicknesses of lint with the electrode running its whole length and attached to the negative terminal. The positive pad 9 ins square is placed on the middle of the back. With an area of entry of this size it should be possible to give an average patient 20 to 25 m'a for 15 to 20 minutes. If after this application the skin is carefully swabbed with surgical spirit and powdered it should be possible to repeat this treatment on alternate days for at least a fortnight i.e. 6 to 8 treatments in all. If the orthopaedic splintage is such that this wide area of entry is not possible the widest window permitted by the surgeon is the next best and failing this the negative electrode may be placed distally to the plaster. Reliance is then placed on the transportation of the negative electrons to the site of injury. This is not without some value but is definitely not as efficient as where the area of delayed union is accessible. The electrical methods that should be employed when delayed union and open wound co-exist must be primarily directed to assisting in the elimination of sepsis and securing a sound skin covering.

(b) *Ultra violet light*—As soon as this local treatment is started brisk first-degree erythema doses of ultra violet light should be given to the whole of the affected limb for this improves calcium metabolism and also activates the cholesterol in the skin and turns it into Vitamin D.

(e) *Surging sinusoidal*—After the direct current has been used for a fortnight surging sinusoidal should be applied to the whole area the wider the area of entry the better. The strength of this should be just sufficient to bring the muscles into tone at the maximum of each surge and not to cause them to make strong contractions. Relaxation should be complete between each surge. In this way there will be no risk of disturbing immobilisation and there will be the certainty of improving the blood supply at the site of the delayed union.

Commentary

Success by this procedure depends as already said on reasonable apposition absence of active sepsis and, above all reasonably good condition of the individual with of course appropriate surgical procedure. Under these conditions firm union is accelerated in a high proportion of cases and the technique can be a real help to the surgeon. There are no dangers associated with it other than of skin irritation and intolerance from the fairly high concentration of current but careful technique should avoid these.

5 MYOSITIS OSSIFICANS

The affected area will be under treatment by prolonged immobilisation. An improved blood supply helps recovery. This can be secured by an inducto-thermy coil wound round and over the part (even if this is encased in plaster of Paris).

Apparatus required

- (a) Inducto-thermy apparatus or short-wave with corresponding felts towel or quilting
- (b) Paraffin wax with bandage and usual accessories.

Methods—(a) In the case of an elbow immobilised in plaster the quilt is wound round the cast with the coil outside the quilt. The current should be applied every day for 10 minutes only. The heat generated by this apparatus acts on the whole depth of the encased limb more rapidly. As the plaster modifies the normal heat losses it lasts longer than when the part is uncovered as in the usual technique. The appearance of any discomfort in the field of treatment should always be reported with this as with any other diathermy treatment.

(b) *Paraffin wax*—Paraffin wax may be employed with considerable benefit when the surgeon has decided that the affected joint may begin to be removed from its fixation (see page 172)

Commentary

Passive forced movements have often been employed in the past and have definitely contributed to bring about opposition to physical measures in orthopaedic injuries. It is obvious that strenuous massage and passive stretching of a joint with an essentially inflammatory condition such as myositis will tend to make the condition worse and favour ossification.

C. PRESSURE PALSY

In crutch palsy the first care is, of course to remove any pressure by changing the type of crutch to an elbow crutch or some similar modification. Then before returning to the use of the crutch on recovery, its size, pad and method of use should all be carefully supervised.

In operation-table palsy the common error made here is failure to introduce physical treatment sufficiently early and failure to order the correct type of physical treatment for the condition.

Electrical Methods

The electrical method of genuine value in crutch palsy is the immediate use of the anodal galvanic current in the axilla the negative being placed on the opposite arm or on one of the legs. The axilla should be well packed with cotton wool wrung out in normal saline and a current of 2 to 3 m.a for 15 minutes used. This should be given daily for not more than 3 days. A change should then be made to long wave diathermy or short wave. If long wave diathermy is used a rolled electrode covered with 2 thicknesses of lint is fitted into the axilla the other electrode should be kidney-shaped and placed on the top of the shoulder. If short wave is used the technique as for a boil in the armpit with a glass electrode should be used. These electrical methods are of course given in conjunction with the re-education of voluntary movement. The practitioner will

field should pass through the brain. Details of a technique suitable for this condition are given below as for antritis.

The successful results of this treatment depend of course upon the actual conditions existing in the ear and whether there is any previous infection or not but it is a condition that repays early treatment. The results are also improved if the treatment is given at the bedside and the patient does not have to be taken to a special department for it.

The percentage of complete success with this technique is not high but it shortens the period of total disability and makes the patient more comfortable.

II Antritis and Sinusitis

Short wave is the treatment of choice for these conditions provided there is drainage. Pads are definitely better than metal discs in glass or ebonite containers for with the latter there is always the liability that some areas will be overheated or inadequately heated. The technique given below yields on the whole better and more consistent results than the utilisation of discs.

Apparatus required

Short-wave apparatus, 1 small and 1 large pad 2 spacing felts, face towel sandbag or elastic bandage.

Method —(a) The patient lies on his side with the affected antrum uppermost. The towel is placed over the face then two felts and then the small short-wave pad with its centre over the affected antrum and secured either with a light sandbag or a suitable elastic bandage. The large pad is put on the couch alongside the patient either opposite his lumbar region or even further down the couch. This ensures adequate concentration at the small pad with rapid dispersal of the field without risk of harm to the base of the brain or ear.

Treatments are given daily. They should always begin with a short treatment of 6 to 8 minutes and then progress slowly from this towards 15 to 20 minutes. If both antra are affected or all the sinuses the patient turns over and the other side is similarly treated.

(b) *Infra red*—Infra red in the absence of short wave diathermy has been used with benefit especially in chronic infected antra which have good drainage. Here too small

doses are desirable and should always be given through a single thickness of lint or a face towel and never directly on to the face

Commentary

Infected antra and sinuses are among the conditions most amenable to short wave treatment but as mentioned above drainage must be adequate. There must of course be no question of malignant disease in the antral region.

III Blepharitis Conjunctivitis and Corneal Ulcers

In these conditions physical treatment should always begin with the direct current. This is of genuine clinical value provided that the underlying condition of the patient is amenable to the treatment and not due to a venereal infection.

Apparatus required

A source of direct current. This should preferably be derived from a battery or accumulator with a milliammeter whose scale is sufficiently wide to enable accurate reading to be made between 1 to 5 m.s. Cotton wool, collosol argentum and 1 flex without an electrode are required, in addition to the usual accessories.

Methods—The patient lies on the back, and undiluted collosol argentum is instilled into the conjunctival sac. A pointed wick of cotton wool also soaked in the collosol argentum is inserted into the inner canthus of each eye so that they can act as a continuous wick, or feed supply to the conjunctival sac throughout treatment.

Flat pledges of cotton wool soaked in a 1 in 4 solution of collosol argentum are then carefully placed over the whole of each eyeball with the lids shut. A larger pad of cotton wool soaked in tap-water is placed over the bridge of the nose so that each end makes contact with the pledges on the eyeballs. A piece of flex, with 2 or 3 ins. bared, is now wrapped in another piece of cotton wool and carefully inserted in the outer layer of the pad (Fig. 22) the whole being held in position by a rubber bandage tucked under the pillow. The other end of the flex is now connected to the positive terminal of the direct current apparatus. The negative terminal is connected to a pad applied round the leg i.e. as far away as possible from the source of entry. The current dosage should not exceed 2 to 3 m.a.

for 12 to 15 minutes. This treatment should be given daily up to a maximum of 14 days.

Short wave.—This current should be given with the technique described for antritis (page 148) and should be given daily until the condition has cleared up.

Commentary

Where short wave is available for these conditions the length of time of treatment by the direct current may in suitable

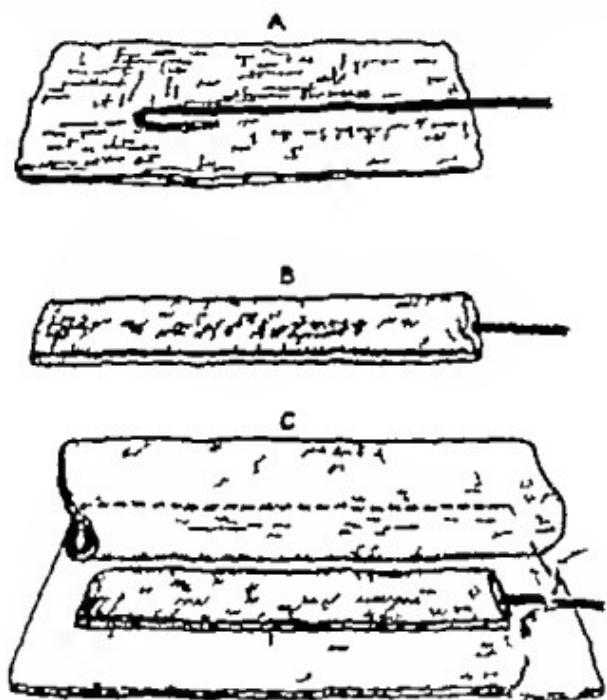


FIG. 22.—Stages employed when using partially bared foil as an electrode.

(a) The loop made in the exposed core to prevent "slip". (b) Shows how warping the foil secures and soft wire for distributing the current to the pad. (c) Pad into which foil is inserted.

cases be materially reduced. A change-over to short wave may be made in 8 or 4 days when the response to the direct current has been particularly favourable.

IV Boils and Carbuncles

Short wave diathermy finds one of its most useful applications in the treatment of these conditions. When short wave

therapy is used in the pre-purulent stage the infection can often be aborted without pus formation. When however the tissues have begun to break down the treatment accelerates the process by which the boil or carbuncle comes to a head and discharges effectively.

Apparatus required

Short-wave diathermy with 1 glass disc electrode and 1 large pad. If the glass disc electrode is not available 1 small pad and 1 large one. Cotton wool and appropriate felts.

Methods—(a) When using the glass disc electrode in short wave diathermy it is essential to have the patient in a stable position and unable to move towards or away from the electrode. For example a carbuncle forming on the back of the neck can be treated satisfactorily by the patient sitting on a chair the reverse way and resting his forehead on a pillow placed on the chair back. The glass electrode can then be brought up to the back of the neck and focused at any required distance from the carbuncle with the certainty that the treatment can be carried out without alteration of the gap.

A large pad electrode is placed on a small table close to the middle of the patient's back. In this way the field passes from the glass electrode at the neck down the back to reach the pad electrode lying on the table. This technique ensures sufficient concentration at the site of the carbuncle or boil and satisfactory divergence of the field. Treatment should be repeated daily starting with a minimum dose of 10 minutes and increasing to a maximum dose of 20 minutes. After treatment surgical spirit and a dry dressing should be applied to the area *not* *somentations*. Treatment should be continued until either the carbuncle or boil has aborted or until where there has been a discharge of pus bright blood specks make their appearance.

If pads are used a ring of several thicknesses of gauze tissue is the best device for separating the pad from the boil or carbuncle and the technique is then as effective as that given by the glass electrode.

(b) *Infra red*—Infra red radiation can be utilised when short wave is not available. This is best given by direct irradiation for 10 to 15 minutes twice a day. Dry dressings and surgical spirit should be used between treatments rather than fomentations.

(c) *Ultra violet light*—Ultra violet light particularly if a

Kromayer lamp is available can be used with benefit. The inflamed area round the boil or carbuncle appears to tolerate a much larger dose of ultra violet light than the normal skin. For these rays to be effective it is essential to give 3 or 4 times the minimal erythema dose. If the extent of discharge permits it the area should then be covered until the next treatment with elastoplast or by some other material such as tulle gras for excluding the air.

Commentary

Physical treatment is most successful in early cases less successful when the institution of treatment has been delayed or in the presence of intercurrent disease such as diabetes.

The only dangers or contra indications are those that apply in general to the use of short-wave diathermy and the other methods described there are no special dangers or contra indications that apply to boils or carbuncles in particular.

V Chilblains and Raynaud's Disease

For these conditions the current of choice is the direct current. Approximately one third of the cases treated will derive permanent benefit one-third temporary benefit and one-third will be entirely unresponsive to any electrical method.

Apparatus required

Any source of direct current a 20 per cent (stock) solution of sodium salicylate weak tincture of iodine 1 Schnee arm bath and usual accessories.

Methods—In the case say of chilblains of two feet the first application is made by painting one foot with the tincture of iodine (which is allowed to dry completely) then placing over this 10 thicknesses of lint soaked in 20 per cent sodium salicylate the other foot being covered to the malleoli in the Schnee bath. The foot with the iodine and sodium salicylate is attached by a suitable electrode to the negative terminal of the source of current and the bath to the positive 5 to 10 m.a are given for 20 minutes and at the next attendance the treatment is repeated but on this occasion the foot that had the iodine and sodium salicylate is now the one to be immersed in the bath. A minimum of 2 treatments a week should be given for at least

4 weeks Any one course should not exceed 12 treatments and 1 per week should be sufficient towards the end of the course

Surging sinusoidal—Surging sinusoidal current should be employed if the above technique does not give genuine signs of progressive improvement after 4 treatments. This should not be given by pads but by placing the affected extremities in Schnee baths even if all four extremities are affected by this condition. A long slow strong surge is better than a short rapid one and treatment should be given 3 times a week for 20 to 25 minutes.

Short wave or long wave diathermy or inducito-thermy—This is always worth trying in cases of chronic recurrent chilblains or Raynaud's Disease when these are resistant to either of the two methods mentioned above. In the case of long wave diathermy if it is the hands that are affected the best technique is to bandage the hands on to two standard handles and apply the current from arm to arm for 20 to 25 minutes avoiding aching at the wrist but ensuring that the current has become perceptible to the patient at least as far as the elbow. In the case of the feet electrodes of the size of the sole of the foot covered with 2 thicknesses of lint soaked in brine firmly bandaged on and with a pillow between the legs to prevent their touching during treatment should be employed.

Inducto-thermy or short wave—If the inducto-thermy coil is available the best technique is from hand to hand or in the case of feet from foot to foot by placing the two bands or two feet alongside one another on the top of the coil with suitable spacing felt or with the palms of the hands facing each other with a spacing piece of felt between them both hands are now wrapped in a thick dry towel, and the coil put round the hands over the towel.

In the case of short wave place one hand or one foot on each pad with appropriate spacing pieces until the whole of the affected limb is adequately warm. This treatment should be given not less than twice a week and preferably 3 times a week, for a minimum of 6 treatments.

Commentary

The clinical criteria for success with any of the above methods are that the general condition of the patient should have been

considered and appropriate action instituted before any electrical treatment is given as if currents only are relied upon to produce a cure there will be a large number of disappointments.

VI. Epidermophytosis (Athlete's Foot)

This infection, despite the most stringent hygienic control, is particularly common among troops who occupy the same barracks for any length of time. It manifests itself in two types the inter-digital and the ungual. The inter-digital is more amenable to treatment than the ungual. As the mould responsible for the condition tends to penetrate and get into levels below the surface it is difficult to eradicate and it is for this reason that dermatologists use lotions which remove the surface epithelium before starting on radical fungicides. All pathogenic fungi are peculiarly susceptible to copper or iodine even in great dilutions and to a certain extent the same applies to the zinc and salicylate ions.

As ionisation can be made to carry these ions forward into the deeper tissues it is the current of choice for this condition, in addition to the usual local applications provided these are not too desquamatory. Neither should ionisation be used when the carbolic and camphor technique has been employed. Zinc can also be used with considerable benefit.

After a considerable amount of investigation the technique below has been found the most suitable

Apparatus required

Any source of direct current 20 per cent stock solution of sodium salicylate 10 per cent stock solution of copper sulphate 2 Schnee arm baths and usual accessories.

(*Note* It is better to use arm baths than the usual foot baths for with these it is possible to watch the treatment readily and see that the solution just covers the toes and no more.)

Method —(a) One arm bath is filled with a warm $\frac{1}{2}$ per cent solution of copper sulphate the other bath with a warm 1 per cent solution of sodium salicylate both to a depth of 1 m. (*Note* $\frac{1}{2}$ per cent solutions contain many times more ions than can be transferred from these solutions to the patient with the time and current recommended. They are given as a practical working basis.)

An appropriate electrode hanging over the end of each

bath and dipping into the solution is now adjusted at the end nearest the toes. The electrode in the copper bath is connected to the positive terminal and that in the other to the negative terminal 10 m.a for 15 minutes should be given if possible allowance being made for sensitive patients.

If at the surface of the solution the skin tends to be excessively aware of the current it is advisable to vaseline a circle round the foot an inch broad at the water level. On restarting the current 5 m.a for 20 to 25 minutes may be used instead of the bigger dosage.

After the treatment is completed the foot should be thoroughly dried and the patient instructed to wipe the toes and between the toes every night with methylated or surgical spirit.

This treatment is repeated on alternate days for a minimum of 12 treatments however well the condition appears to have responded. After every 3 treatments i.e. 1 week the foot that has received the copper ions now receives the salicylate ions and vice versa.

(b) *Ultra violet light*—Ultra violet light hinders the growth of the fungi associated with epidermophytosis. It is therefore useful in the more resistant type i.e. the unguial type. It is best given by means of the Kromayer lamp. If for instance a single toe nail is infected the nail should be well filed then painted with 2 per cent silver nitrate. As soon as this is dry an applicator the size of the nail is applied until the area is negroid in colour. Large doses may safely be given with this technique. It was described by Professor Huldhinsky and is known as the Kromayer Huldhinsky technique.

Commentary

As the fungus grows in the thickness of the nails and burrows into the skin nail surfaces should be filed before ionisation to permit entry of the current to these areas of high resistance. Similarly all dead skin between the toes should be removed before starting treatment.

Appropriate treatment of socks, shoes and other material from which reinfection can occur is essential.

In the case of long standing unguial infection it is necessary to persist with variations in technique for a long time.

VII. Glands and Bursitis

The water-cooled mercury vapour arc is of great clinical value in the treatment of chronic adenitis and bursitis.

The water-cooled mercury vapour arc apparatus is known as the Kromayer. This apparatus originally devised by Kromayer for the treatment of lupus was found to have certain very definite advantages over the original Finsen apparatus. It could for instance be utilised for treating lupus in places inaccessible to the Finsen applicators, such as intra nasal, palatal or similar sites in mucous membranes. Some years ago it was also observed that if applications were made with this apparatus to the common chronic glands in children, combining this with general ultra violet light the clinical results were considerably improved. Further investigation of the possible field of utility of this apparatus made it clear that it had a valuable effect on the majority of chronic glandular enlargements even when these were clearly not tuberculous. It also appeared to have almost a specific effect on enlarged bursae. The question naturally arose How could an ultra violet ray which had little penetration have effects on patients which could not be secured by ordinary ultra violet light? The physical differences between treatment by the mercury arc operating in air and one operating through water are as follows.

Firstly the water-cooling device enables the source of the ultra violet light to be brought into close and intimate relation with localised areas. Secondly the ability to use pressure as is done in the Finsen treatment makes the part to be treated relatively ischaemic and thereby allows greater penetration of rays which would otherwise be absorbed by the capillary blood carpet. Thirdly circulating water filters off the majority of all the short and long infra red rays but is itself transparent to a narrow band of infra red rays at about 7 000 to 9 000 Ångström units.

Is it this factor that is of importance or a combination of all three factors—or is it some as yet unknown physiological action that takes place when treatment is given that has been built up on successful clinical experience? An answer to these questions is greatly to be desired but it is not necessary to await it to define the scope and value of this method.

When glandular enlargement is associated with rheumatism

the Kromayer lamp gives results which cannot be secured by any other method. The particular types of rheumatic affection that are benefited are those with some definite evidence of a chronic infection of the lymphatic system as shown by enlarged and tender glands. Where these glands on pressure also produce radiating pain the outlook for a good response is considerably enhanced. For instance a chronic brachial neuralgia with enlarged and tender neck glands which on pressure radiate discomfort over the shoulder or arm is almost certain to benefit from Kromayer applications.

Apparatus required

A Kromayer apparatus with applicators of sufficient length and cross section so that when in use pressure on neck glands, subacromial, popliteal and other glands can be secured. Also applicators to reach tonsil. A quartz filter that can be fitted behind the applicators and that will cover the whole face of the apparatus.

Methods.—A patient with tender enlarged pain radiating neck glands may be taken as an example. The Kromayer having been run up until it is fully operative is fitted with an application about 3 in. long by $\frac{3}{4}$ in. diameter (*Note*. If D.D. is used with the old type of mercury arc it is essential to see that the applicator is accurately located opposite the surface of the negative side of the arc). One of the tender large glands is then located and for an average type of patient an initial application of 10 seconds is made with firm pressure even if the gland is tender. Six such applications are made on each side (Fig. 23). Treatment is repeated not more than twice and not less than once weekly.

The patients should be warned of the ring like erythema areas with subsequent browning that will appear. If they are particular about such markings on their skin then the blue filter should be interposed. But this reduces the effectiveness of the treatment to at least half and allowance should therefore be made.

Progress in length and number of applications is made



FIG. 23.—Sites for application of Kromayer rods to neck glands.

according to the clinical response. Clinical improvement is often slow but when once started is steady.

This individual treatment of glands is also of value for the treatment of large popliteal glands a common occurrence in some forms of rheumatic knee affections also in other glands such as iliac or even mesenteric.

In treatment of bursal conditions a different technique is employed. Here the bare face of the apparatus without any applicator is applied with strong pressure to the affected area commonly the deltoid. The duration of each application is at least equal to 3 times an erythema dose and may be as much as 6 times. The area so treated should then immediately be covered with 2 thicknesses of elastoplast (provided that the patient is not sensitive to it). The elastoplast should be left on for at least a week preferably a fortnight when the treatment can be repeated. This treatment for cases of sub-deltoid bursitis has a high degree of success even in cases where some radiological changes can be seen in the bursa.

In skin-sensitive cases and when pigmentation is to be avoided the blue filter must be used with correspondingly reduced doses to those suggested. The results however are never so good.

Intensive Kromayer irradiation followed by the application of elastoplast is sometimes of great use in clearing up the residual stiffness of an otherwise recovering arthritis.

General carbon arc or mercury vapour lamp—In all chronic gland cases clinical results are enhanced by regular long slowly built-up applications with definite tanning of the body over wide areas. As each patient reacts differently to ultra violet light individual treatment is essential. Group irradiation is not suitable for the treatment of chronic inflammation of the glands. Patients with chronic glandular infections are susceptible to cold and for this reason when the mercury vapour lamp has to be used instead of the general carbon arc, some form of radiant or infra red heat should be used at the same time.

Commentary

It should be remembered that ultra violet light generated by mercury vapour lamps has a wave band of 1 850 Ångström units. This band is the one that makes ozone which is an

irritant to bronchial tubes especially among those liable to asthma have fever and similar conditions

VIII Headaches

The headaches following concussion spinal injury or lumbar puncture can usually be relieved by the use of the direct current

Apparatus required

A battery or accumulator operated source of direct current a largish quantity of cotton wool and usual accessories

Method—A pad approximately 6 ins square of 6 to 8 thicknesses of lint and attached to the negative is applied to the back of the neck. A small wet cotton wool swab is placed over each eye with the lids closed. A large pad of 2 full thicknesses of cotton wool is applied over the eye pads and the greater part of the forehead and attached to the positive the whole being held in position by a rubber bandage tucked under the pillow on either side.

The current is now started very slowly and increased to 2 m.a only. The initial treatment is for 8 to 10 minutes and if beneficial may be repeated again the same day. In any case treatments do not exceed a maximum of 15 minutes. At the cessation of treatment the current must be decreased equally gradually before being switched off.

Commentary

This technique is so consistently beneficial in suitable cases that failure should suggest the presence of abnormality. Any increase of headache with this treatment is a definite contra indication to its continuance.

IX Incontinence of Urine

This condition so commonly present after difficult birth can be materially helped in some cases. The technique given below is not suitable where bladder or other infection exists but is applicable to those cases where the pelvic diaphragm has become stretched and toneless. It should be employed as a method of pre and post rehabilitation in all colporrhaphy operations. The technique given here was originally described by Dr Bathurst in 1938.

Apparatus required

Any source of direct current a faradio coil with attachment for automatic surging of the current or a surging sinusoidal apparatus 2 pads of 6 thicknesses of lint about 9 by 6 ins. 2 electrodes 8 by 5 ins 2 pieces of flex bared at both ends sandbags and usual accessories. A dressing trolley laid with the following sterilised articles is prepared —

- (a) 1 large kidney dish.
- (b) 1 dressing bowl containing a warm 2 per cent Dettol solution.
- (c) 1 pair of sponge forceps the stem covered with wide bore rubber tubing allowing the handles to be opened slightly At the far end for insertion into the vagina the tubing is turned back $\frac{1}{2}$ of an inch
- (d) Drum containing swabs towels (3 towels are required at each treatments) one strip of lint 12 by 2 ins and 1 pair of rubber gloves
- (e) Cheatle forceps
- (f) Jar with a wide neck containing sterile 2 per cent zinc sulphate made up with mucilage of tragacanth standing in a bowl of hot water (Note This should always be freshly made as it does not keep for more than one week.) (A non greasy sterile surgical lubricant such as "Lubafax" (Burroughs Wellcome & Co) may be used as an alternative to mucilage of tragacanth in which case the zinc sulphate is made as a separate solution.)
- (g) Bowl for dirty dressings

Method — This method should be carried out with aseptic precautions The technique falls into three parts

- (a) Preparation of the patient
- (b) Connecting the apparatus.
- (c) Administering treatment

Before treatment is started the patient is instructed to pass urine She is then placed on the couch with the sacral region resting on a firm pillow and the knees are full flexed and widely abducted.

(a) *Preparation of the patient* — A pad about 9 by 6 ins is placed on the lumbar region above the sacro-iliac joints a similar pad is placed on the abdomen and held in position by a heavy sandbag After scrubbing up and putting on gloves the physiotherapist winds the lint round the ends of the sponge forceps This is done by gripping one end of the lint between the forceps and winding the remainder round to form a mop The free end is anchored by rolling the turned back portion of

the rubber tubing over it (Fig. 24) Standing at the right-hand side of the patient the physiotherapist places one sterile towel under the buttocks and one covering each thigh, overlapping the pubic area. The vaginal orifice is swabbed with the Dettol solution. The mop is then dipped in the 2 per cent zinc sulphate and mucilage of tragacanth solution. The labia majora are separated by the left hand using the thumb and index finger.

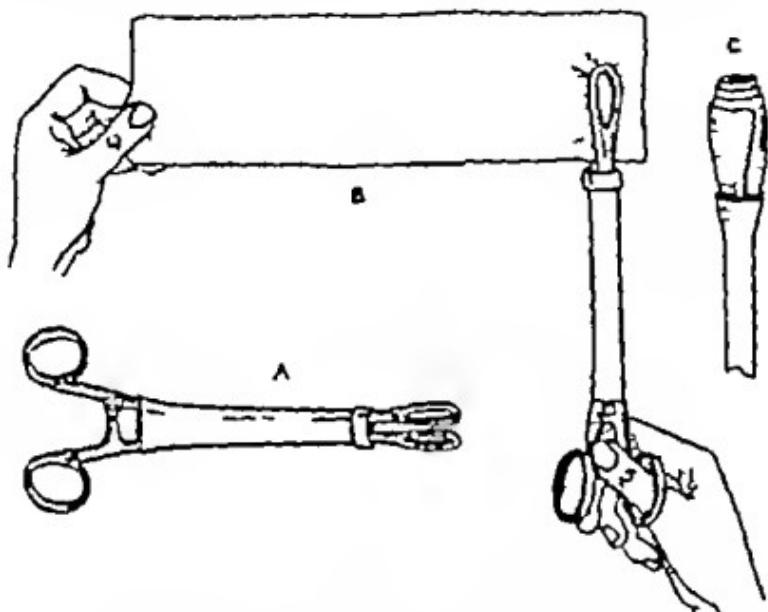


FIG. 24.—Preparation of forceps for Bathurst Treatment

(a) Illustrates the process of a loosely fitting rubber tube so that the forceps can grip, (b) the strip of lint preparatory to rolling in into the final position, (c) as described in the text.

the dressed forceps are held in the right hand and gently inserted into the vagina as far as possible without discomfort

Before beginning the second stage of the technique the gloves should be removed

(b) *Connecting the apparatus*—The free terminals of the electrodes incorporated in the two pads are united to form a common lead. This common lead is attached to one of the terminals of the faradic coil or surging sinusoidal apparatus. The other terminal of the faradic coil is attached to the negative terminal of the source of direct current to be used. The positive of this source is now connected to the handle of the vaginal sponge forceps which is covered by a mackintosh.

(c) *Administering treatment*—The direct current is now given until about 5 to 8 m.a. are registered. The surging faradic

current is then added to a strength that the abdominal muscles and those of the thighs and legs may be seen to be contracting and the patient describes a feeling of her inside being lifted up. This current is given for 15 to 20 minutes at each treatment. Treatments should be given 3 times weekly at first and later twice weekly for a total of at least 12 treatments.

Exercises

Exercises to strengthen the pelvic floor are extremely helpful in enhancing the value of this treatment.

Pelvic tilting exercises and abdominal contractions in crook lying and the knee-chest position should be given. Attention should also be paid to the patient's posture which is often poor. The following useful exercise should be given to the patient to perform between treatments. She should be told to breathe out and at the same time contract the gluteal muscles with anal in pressing and adduction of the thighs. This may be carried out in either the sitting or standing position and should be repeated 20 times. The patient should be instructed to do it for 2 minutes every 2 hours if possible.

Commentary

The technique given here is a modification of that originally described by Dr Bathurst. Fluctuations and swinging of the needle of the milliammeter during this treatment has no significance. If it tends to do so and is not a centrally situated needle it is as well to short-circuit the milliammeter from the circuit.

The relief of symptoms does not usually begin until six or more treatments have been given. The best early sign of improvement is diminution in frequency or the disappearance of leakage during coughing or sneezing.

X Pruritis

This intensely distressing condition can sometimes be greatly relieved by a technique originally described by Professor Huldschinsky.

Apparatus required

Portable mercury vapour lamp or preferably a Kromayer 5 per cent silver nitrate cotton wool mops on sticks and material for screening parts not to be irradiated.

Method—(a) With the patient in the lithotomy position the whole of the pruritic area after having been cleansed is carefully swabbed with 5 per cent silver nitrate for about 2 minutes care being taken that at the end there is no wet solution left on the affected parts.

An application of ultra violet light is now given to this area suitable protection being provided to all parts that have not been swabbed with the silver nitrate. The strength of dose is 3 times a full erythema dose. This dose should not produce any erythema and if the application of silver nitrate has been successfully carried out the whole pruritic area should turn almost negroid black. This treatment should be repeated for 3 days. The area should be powdered with sulphamamide powder between treatments.

(b) Zinc ionisation—Zinc ionisation may be used if the Huldhinsky technique is not successful but the latter should always be tried first for it usually gives most dramatic relief.

Apparatus required

2 per cent zinc sulphate or collosol argentum 1 lead with flex bared at both ends, and usual accessories.

Method—The patient lies in the prone position and a pad of cotton wool soaked in 2 per cent zinc sulphate and incorporating a bare flex in its centre is applied to the whole of the pruritic area. If necessary an additional piece of cotton wool wrung out in the solution is packed in between the vaginal folds. The flex from the pad is attached to the positive terminal of any source of direct current and the negative terminal is attached to a pad of lint some 6 ins square. This indifferent pad is placed on the small of the back and fixed by a sandbag. A 5 to 10 mA is given for 15 to 20 minutes and treatment may be given 3 times a week. Collosol argentum may be used in preference to the zinc if desired. If the condition is not rapidly improved after 6 sessions the treatment should be discontinued.

Commentary

As pruritis is frequently associated with intestinal sepsis relapses are bound to occur unless this is investigated and if necessary treated as well as the local conditions.

It is rarely necessary to shave patients who have this

condition as those well covered with hair in this area rarely suffer from this disease

XI. Pyorrhœa

There are two treatments of choice for this condition one ionisation the other focal irradiations with *Kromayer* applicators. The treatment of pyorrhœa by ionisation is usually undertaken by dental surgeons but the physiotherapist may sometimes have to carry out this treatment.

Apparatus required

Direct-current apparatus preferably of the battery type 2 per cent zinc chloride zinc wire cotton wool fine rubber tubing and usual accessories

Method —(a) A length of zinc wire such as is obtained from any ironmonger of $\frac{1}{4}$ in diameter is slipped into a piece of the fine rubber tubing so that about 1 in protrudes from either end. To one end a flex from the positive terminal of the direct current is twisted on. At the other end a small piece of cotton wool is teased out and rolled on to the wire so as to cover it entirely but very thinly and the rubber is drawn down to help to hold it in position. The cotton wool is then dipped into the 2 per cent zinc chloride solution connected to the positive terminal and applied to each pocket in turn. A current of 2 to 3 m.a for 2 minutes is given. Between each application the cotton wool is renewed and dipped again into the zinc chloride. The cathode should be applied at a distance i.e. to either arm or leg. By this process zinc ions with their known disinfecting properties are driven into the affected gum tissue and at the same time the chlorine ion is momentarily freed and appears to help in the cleansing process of these infected pockets. This treatment may be repeated once a week for 6 weeks.

(b) *Kromayer rods* —The firm marketing the *Kromayer* apparatus supplies rods especially for the treatment of gums. The sensitivity of the patient's gums should be tested before a full treatment is given. The latest *Kromayer* models have an output 3 to 4 times that of the original models. It is therefore impossible to state in seconds the average dose. If a test is made on the patient's forearm to ascertain a second degree erythema dose three-quarters of this time is usually suitable for the gums and at subsequent treatments the time

can be rapidly raised as gum margins readily acquire ultra violet light tolerance. The rod supplied covers approximately the area the root of the tooth.

Commentary

Mandeval showed that by combining these two techniques there was a high percentage of clinical and radiological improvement particularly in the cold abscesses developing round upper incisors in children after a blow on the teeth. Teeth so treated, though devitalised can become firm and secure in their sockets.

XII Septic Sinuses

Infected sinuses are not nearly so common as they were 20 years ago. Provided that they do not lead down to a sequestrum or to an opening in the bowel or that they are not excessively long and sinuous they can often be completely healed by intelligent alternation of ionisation, ultra violet light and short wave. Before treatment especially in dealing with long sinuses in dense tissue an X ray examination of the track is helpful and should be repeated periodically as a guide to the physiotherapist.

Apparatus required

Direct-current supply collosol iodine collosol silver 2 per cent zinc sulphate fine rubber catheter barrel of a 10 c.c. record syringe flex with the wire exposed at both ends and usual accessories.

Method —(a) Treatment by this method should be carried out under aseptic precautions. After removal of the soiled dressing the sinus is cleaned with sterile water. The rubber catheter is then inserted into the sinus and the other end attached to the barrel of a record syringe from which the plunger has been removed. Collosol iodine diluted to half strength with sterile warm water is poured into the syringe and the exposed wire at one end of the flex is dipped into this solution. The flex is then strapped on to the syringe so as to retain it in place. The other end of the flex is now attached to the negative terminal of the direct current and a pad some 6 ins square is applied as nearly anatomically opposite as possible (Fig. 2.) The current is then turned on. If there is an adequate continuity between the collosol iodine in the sinus and that in the record syringe there will be no difficulty in registering a flow of current. This should then be adjusted

to 5 to 10 mA for 5 minutes on the first occasion or even less if it is more than slightly uncomfortable to the patient. A favourable response to this technique is indicated by a report that the discharge is increased but definitely thinner the day after treatment. This is because this technique owing to the

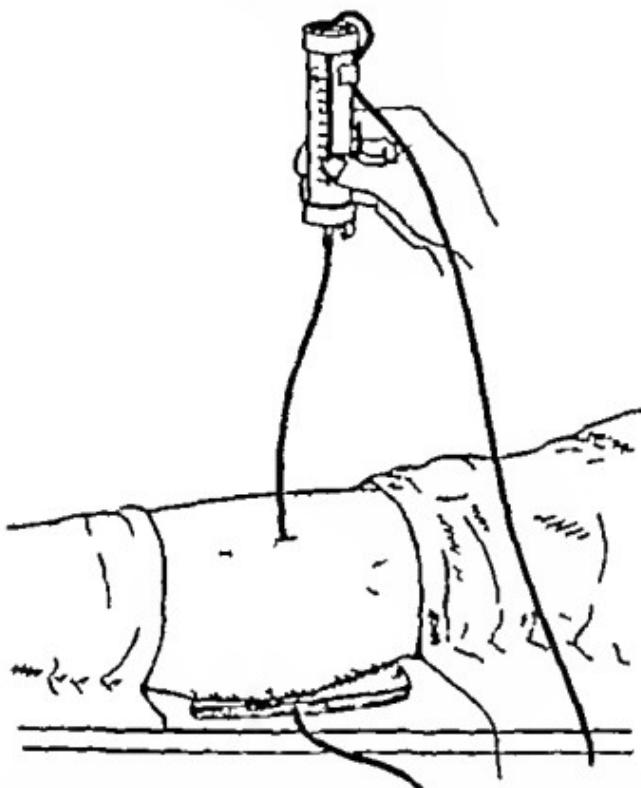


FIG. 25.—Ionisation of sinuses by means of catheter and record syringe. The nearer the bottom of the sinus the catheter can be introduced the more beneficial the results.

production of alkali at the cathode dissolves mucus and tends to make secretion more active.

After 2 or 3 days of this treatment when the second stage is reached colloidal argentum diluted to half strength or zinc sulphate 1 per cent is used the flex attached to the record syringe being connected to the positive terminal of the source of supply and the pad on the opposite side at the negative terminal. This treatment can be repeated daily until progress definitely slows up or ceases. This is judged by diminution of the length of the sinus and gradual diminution of the amount of discharge.

In deep and long sinuses these methods cease to be effective after about a fortnight's treatment and change of technique is then necessary.

(h) *Kromayer*—The Kromayer apparatus can be fitted with applicators of all sizes including specially constructed sinus rods. Straight rods are more effective than curved and sinuses whose furthest end can be reached clearly respond better than tortuous ones. It is difficult to overdose a sinus with these rods and 5-10 or more minutes may sometimes be required to obtain a suitable reaction. Sinuses treated by Kromayer irradiation should show less discharge at each treatment.

(c) *Ultra-violet light*—Ultra violet light in general tonic doses to increase the general resistance and condition of the patient should be given simultaneously with sinus ionisation. This procedure usually expedites recovery.

(d) *Short wave*—Short wave treatment to the area of the sinus is often helpful particularly when this is surrounded by dense fibrous tissue which requires a better blood supply.

Commentary

Infected sinuses respond well to treatment by electric currents. The patients should, however, be treated in bed under hospital conditions not as out patients. Failure to adopt this course results in retarded recovery.

The contra indications to this technique have been indicated above—namely sequestra, faecal fistulae and tortuous sinuses leading down to chronic abscess cavities.

VIII Thrombo Angitis Obliterans

This condition with its outstanding symptom of pain in the affected part after a limited amount of exercise can be relieved, though not cured by applications of short wave diathermy or inducto-thermy. Occasionally histamine ionisation is of temporary value. Short wave diathermy affords such comfort to the patient that a long course of treatment is always justified. The patient may also be instructed in Buerger's Exercises by which the vessels are alternately emptied and filled. In addition, toe and ankle movements may be performed.

Apparatus required

Short-wave diathermy or Inducto-thermy spacing felt, towels and quilting

Methods—(a) If one leg only is affected, the following method is the most satisfactory. With the patient seated on a chair one pad covered by two felts is placed on the floor and the sole of the foot is rested on the felt—the other pad covered by two felts and one towel is placed under the buttock of the affected side or the pad with the intervening felts may be placed over Hunter's Canal so as to bring the femoral artery with its sympathetic fibres more directly into the field.

A long application of 25 to 30 minutes once a week for many weeks gives better results than a short intensive course.

The best that can be expected of either of these treatments is improvement in walking and diminution of pain. There is nothing curative in either method.

(b) *Histamine ionisation*—Histamine ionisation occasionally benefits certain patients far more than short-wave diathermy. It should always be tried if the former has not given adequate relief. The preparation and method are those described on page 4. The current is made to enter at about the middle of the painful area and in the case of a leg the negative terminal of the current is applied high up in the inguinal region.

(c) *Buerger's Exercises*—The patient is instructed to perform these exercises twice daily for 15 to 20 minute periods. The limb is elevated on a suitable sloping support such as an inverted chair covered with a pillow to an angle of 45° for 1 or 2 minutes thereby permitting the veins to empty themselves more easily. The leg is then lowered over the side of the bed until the heel rests on the floor or low stool for a similar period during which the veins become filled with blood. The period of exercise is arbitrary; many have found elevation for 1 minute sufficient.

Commentary

An apparatus known as Pavex has been designed to administer intermittent compression and decompression to legs affected by this condition. Although good clinical results have been reported as a result of its use these appear to be no more permanent than those secured by other methods.

XIV Use of Paraffin Wax

It is becoming increasingly recognised that paraffin wax has a wide range of usefulness as a therapeutic agent. It is especially valuable for mobilising stiff joints and improving the activity of the skin particularly of the dry, pale and inelastic skin resulting from burns and septic conditions of long duration. In these latter conditions the wax should be applied as soon as healing has occurred and, indeed, may be safely used with advantage while there are still small unhealed areas.

Wax packs also give relief in the acutely painful joints associated with rheumatoid and infective arthritis. In the more chronic osteo-arthritic type of joint a decrease of swelling and improved range of movement can often be obtained by wax bandages.

Paraffin wax is a by product of petroleum and is made with a melting point of varying grades. The most useful for therapeutic purposes are two—one with a melting point of 110 F and the other with a melting point of 120 F. These should constitute the main stock.

When the condition of the skin is impaired e.g. by burns the wax with the lower melting point should be used. For general purposes particularly packs and bandages wax with a melting point of 120 F is more suitable.

Wax may be applied by three methods

- (1) Baths.
- (2) Packs
- (3) Bandages

Wax Baths

Wax baths are suitable when hands, feet or elbows require treatment and should whenever possible be the method of choice the advantage being that movements can be carried out by the patient while the limb is immersed. A greater gain in the range is usually obtained in comparison with packs because when packs are used, movements can only be performed after removal of the wax.

Apparatus required

Either (a) a specially designed bath heated electrically or by a steam coil. The manufacturers supply two types—an arm and a leg

be taken when applying the wax that the first coating is free from cracks so that all air is excluded otherwise application of the second coat may produce a burn

The wax may be cracked by movement on the part of the patient or by too vigorous application of the brush by the physiotherapist

Wax Bandages

These are used when it is desired to leave wax in contact with the skin for long periods

Apparatus required

Requisites as for baths and packs in addition some standard 6-yd. crêpe bandages. 2 sizes only are required 3 ins or 4 ins

Method of application — A crêpe bandage of the required width is immersed in a bowl of wax at a temperature of 140 F and re-rolled in the wax to saturate it thoroughly. The joint to be treated is then held over the bowl and the bandage is wound round it additional wax is well rubbed in at each turn using the hand as a scoop in much the same way as plaster of Paris. The bandage is finally covered with jaconet and lightly bandaged to hold it in position. With this method the bandage is usually left on for a period of 2 to 3 days although it may be retained for as long as 7 days if no skin rash appears.

This method also forms a useful 'overnight' treatment for very stiff joints after prolonged immobilisation the bandage being removed during the day for more active work

The bandage is easily removed by exposing it to the infra red lamp for a few minutes before unrolling

Precaution — If a skin rash is forming under the bandage the patient will complain of irritation and on turning back the edge of the bandage the skin will appear erythematous and spotty. The bandage should be removed. The rash is due to excessive sweating. The irritation can be relieved by sponging with a solution of sodium bicarbonate (1 drachm to half a pint of water) followed by calamine lotion. As soon as the rash clears which may not be for 3 or 4 days the method may be resumed.

Purification of Wax

Wax may be purified by the following methods

- 1 By melting and then straining through a fine mesh gauze. This is sufficient for removing coarse deleterious material.

- 2 By clarifying The wax should be boiled in water for 10 minutes For a large bowl the size of a baby's bath 2 pints of water are sufficient The wax is then left to set when it will be found that all dirt and sediment has collected at its base The soiled section is removed and the wax is then ready for reheating This method is said to be effective for dealing with non-sporing organisms
- 3 By sterilising The wax should first be strained and then submitted to a dry heat at a temperature of 150° C for 1 hour This method is effective for dealing with all organisms sporing and non-sporing

CHAPTER 10

OCCUPATIONAL THERAPY IN MEDICINE AND SURGERY

OCCUPATIONAL therapy may be defined as the scientific use of any form of occupation or work in the rehabilitation of the unfit. It may be divided into 2 branches (1) with a predominantly physical objective i.e. in the rehabilitation of physical disabilities following disease and trauma and (2) with a bias towards the occupation of the mind in the treatment of mental disorders.

The aim of occupational therapy in all cases is the restoration of function. In physical work this is achieved in 3 ways (1) by using a suitable occupation as a form of remedial exercise e.g. knotting to strengthen a weak grip and mobilise stiff fingers (2) by using occupation as a diversionary measure to prevent boredom and failure of interest in patients needing prolonged treatment, and (3) by using a period of remedial work under sheltered or normal working conditions to bridge the gap between the patient's discharge from treatment and his resumption of full work.

This chapter deals with the practice of physical occupational therapy in the restoration of function following such conditions as arthritis, fractures and other bone and joint injuries. It is divided into 3 main sections (1) specific occupational therapy (2) non-specific or diversional occupational therapy and (3) the resettlement of patients in employment.

The purpose of the specific occupational therapy section is to indicate simple occupations which can be used without specialised craft training or elaborate apparatus and to demonstrate the technique of applying them in the various phases of recovery. The purpose of the non-specific occupational therapy section is not only to demonstrate the use of diversional therapy but to show how it can be employed as a spacing or rest device between periods of exercise. The section on resettlement in industry deals with the methods which are used to reinstate patients in light and heavy industries.

The Aims and Application of Specific Occupational Therapy

Specific occupational therapy achieves its best results when combined in the correct proportion with physiotherapy and recreational therapy. It has 7 aims in the treatment of disease and trauma—(1) to conserve muscular function during the period of immobilisation and to prevent atrophy and fibrosis; (2) to conserve full function of the joints above and below the immobilised part; (3) to strengthen weak muscles; (4) to mobilise stiff joints; (5) to re-educate neuro-muscular co-ordination; (6) to teach a normal use of the affected part; and (7) to encourage the patient.

Basic Occupations

Three groups of occupations form the basis of simple occupational therapy—(1) handicrafts; (2) gardening; and (3) domestic work.

Adapting Occupations as Therapy

When occupations are used as therapy they are often carried out quite normally. In other cases they are modified to produce the required movements.

Prescribing Occupational Therapy

The prescription for occupational therapy will be issued by the physician or surgeon in charge of the case. Sometimes it will be specific and indicate the occupation and type of modification required. On other occasions it may merely state

Occupational Therapy leaving the therapist to plan the details of the treatment.

In the final phase of recovery the occupations should be based on the patient's normal work or if his disability prevents him from returning to it on the type of work which will be most suitable for him.

Harmful Factors

It is essential that the amount of exercise given to an affected part should be accurately regulated for it is all too easy to strain weak muscles and traumatised joints. Generally speaking the demands made in terms of stress and time should be directly proportional to the strength of the muscles and the condition and range of the joints. The best method is for the

patient to begin with a light occupation and to work for a limited time which can be determined by the nature of the disability. As the condition improves the working time can be increased each day and the occupation gradually stiffened in strength.

In early conditions which cause pain it is always best to advise the patient to take the movement up to the painful limit *and no further* unless the physician or surgeon has given definite instructions to the contrary. In treating chronic cases such as stiff joints a certain amount of pain is permissible. Before allowing movements which aggravate the pain to any marked extent however, it is best to obtain specific instructions from the medical man.

Treating the Patient

The therapist should explain the rationale of occupational therapy to the patient and indicate how it is hoped to help him. It must be explained that the work is only of remedial value as long as it is carried out in the way indicated. It must also be pointed out that although the finished work is of secondary importance to the method of obtaining it only the highest standard is acceptable.

Occupational Therapy Time Table

The arrangement will depend entirely on local conditions but the usual plan is to divide up the working hours of the department into fixed periods of an hour to an hour and a half the patients being treated in groups or classes. Remedial and diversional cases can be mixed or kept apart. When classes are mixed it allows the patients to sit near their friends which makes them feel at home. When the two types are separated large numbers of patients are more easily handled and greater supervision can be given to the remedial cases—a definite advantage when working with a small staff.

The Aims and Principles of Diversional Occupational Therapy

Diversional occupational therapy can be used in two ways in the treatment of disease or trauma—(1) as a purely diversional measure to prevent patients under prolonged treatment from brooding over their disabilities and (2) to ensure pro-

scribed rest for an affected part between periods of active therapy

Types of Occupations

Any type of occupation can be used for diversional purposes from gardening to domestic work, but handicrafts are generally the most convenient. In some cases it is possible to arrange with local firms or industries to allocate suitable productive work to the occupational therapy department. At one maxillo-facial and plastic centre for example the patients assemble aircraft precision instruments and prefer this to any other form of diversional therapy.

The patient should be allowed to choose his own occupation, as it is essential that it should really interest him. If he shows no preference or is too apathetic to choose the therapist should try to find out where his interests lie and then select the occupation accordingly.

Diversional Therapy as Rest Therapy

The value of diversional therapy as a spacing or rest device between periods of active treatment is not sufficiently appreciated.

In a case of meniscectomy associated with slight effusion for example the surgeon warns the patient not to over use the knee-joint during the first few weeks after weight bearing has been allowed. Between treatments however the patient's activities are not supervised as a general rule and he tends to use his leg too much. As a result he may develop a large effusion of the knee joint which could be prevented if some form of rest therapy were prescribed for him during his free time. For example he could carry out many types of interesting crafts while resting on a couch in the occupational therapy department with his leg supported horizontally on a pillow. If the department were situated at a considerable distance from the ward he could rest on his bed in the same way and the therapist could supervise his treatment from time to time.

Resettlement in Industry

The patients for resettlement fall into 3 groups (1) those who can return to their pre-accident work, either with

flexion of the fingers and small range abduction of the shoulder joints

Slip-loop Knotting

A chain of slip knots is formed. No apparatus is required as the fingers are used as knitting pins. The index fingers take the most active part in the work and are alternately extended and flexed. The knotting requires considerable finger dexterity and co-ordination.

Remedial application—Knotting is a bilateral craft. It can be carried out in standing, sitting or lying.

Flexion of the fingers—Boatswain's knotting is used. Where flexion is limited the knotting material is wound on to a rounded wooden shuttle which is broad enough for the patient to grasp comfortably in his affected hand. As the range of flexion increases the diameter of the shuttle is decreased. Later when full flexion of the fingers has been regained the patient can dispense with the shuttle and work with the material only.

Shuttles

The shuttles are made from dowel rods 9 ins. long by $1\frac{1}{2}$ ins. 1 in. and 2 ins. in diameter (Fig. 20). The ends of the rods are

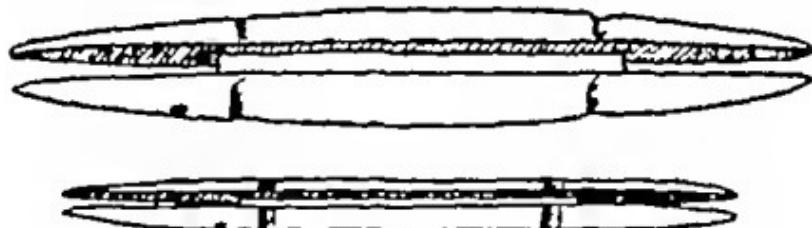


FIG. 20.—Rounded wooden shuttles. The grooves hold the knotting material so that it does not project

shaped to form tapering prongs which are connected by a deep groove cut on either side of the body. The groove holds the knotting material so that it does not project beyond the shuttle and add to its diameter (Fig. 20).

Prevention of trick movement—If flexion is limited at the interphalangeal joints there is a tendency for the metacarpophalangeal joints to be used to the exclusion of the others. To prevent this the patient should wear a plaster splint which immobilises the metacarpo-phalangeal joints. When knotting is used without shuttles the patient may 'trick' the tightening

process. Instead of gripping the strands properly he winds them round his fingers which are used as hooks or holds them between the thumb and index finger.

Extension of the fingers—Slip knotting is employed. With practice the extension movements can be carried out with the middle finger in addition to the index finger but it is not practicable to exercise the other fingers in this way. To make the work easier thick materials such as rug wool should be used.

Extension of the wrist joint—Strong synergic movements of extension of the wrist joint are a secondary feature of all forms of knotting.

Median and Musculo-spiral nerve lesions—In median paralysis boatswain's knotting is used, the material being wound on to rounded shuttles as described. Slip knotting can be employed in the late phase of recovery from musculo-spiral paralysia. If there is complete or partial anaesthesia care must be taken that the friction of the knotting strands does not injure the skin. The craft should only be used for short periods at a time until the reaction of the skin is known. If it is unfavourable knotting should be discontinued. Where the reaction is slight the work can be continued, but some form of protective covering should be worn over the hands such as thin cotton gloves.

Elbow and shoulder joints—Boatswain's knotting is used in two ways to exercise these joints. One way is to alter the normal position of the knotting in relation to the patient e.g. the knotting frame could be clamped to the edge of the table in an upright position while the patient sits on a low chair in front of it. The other way is for the work to be carried out with long strands which are drawn through the knotting loops by the specific movements required as in remedial stool seating (see page 188).

2 Technique of Knotting

Apparatus required—A simple wooden frame on which the various strands of material can be stretched and arranged as required. The knotting frame is used chiefly when working on a table or bench while the adjustable frame illustrated is especially useful for bed work (Fig. 27).

Materials required—A great variety of materials are used

for fancy knotted work such as glace cord, macramé twine, belt cotton and rug wool. For economy they can be blended with cotton twine or American tubular banding (Milband).

Boatswain's Knot

There are 3 main varieties of this knot—the flat, the rolling and the split (Figs 28 to 30). All are formed in much

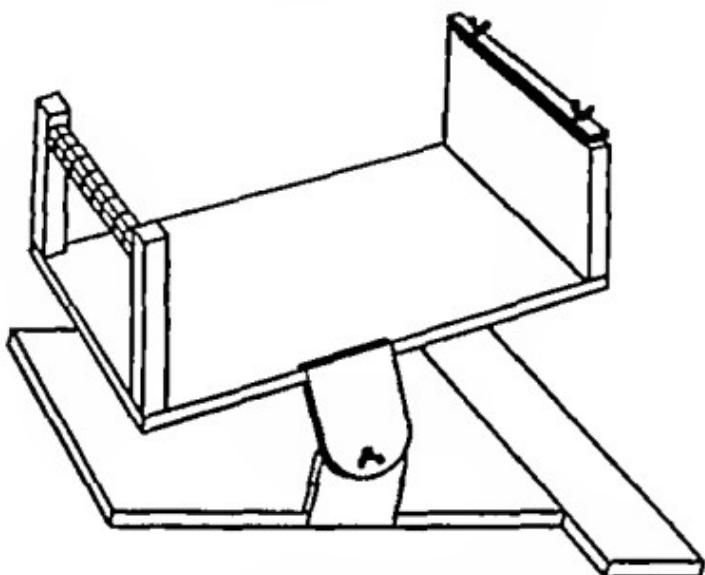


FIG. 27.—Adjustable knotting frame which is especially suitable for bed work.

the same manner but have quite a different appearance when worked continuously. They are employed in the making of knotted dog leads, belts and bags.

The Flat Boatswain's Knot

This consists of a reef knot tied round a core of strands with 2 lengths of material known as threaders. Half the knots are tied on one side of the core and half on the other (Fig 28). The amount of material required is approximately 5 times the length of the finished knotting (See belt worked with boatswain's knots page 186). The core C is stretched tightly across a knotting frame. Threader A is laid over it, threader B is then passed over threader A under the core and up through the loop created by A and the core (Fig 28a). Both threaders are then pulled in opposite directions and the knot is tightened.

up. The same process is carried out again threader B being taken from the opposite side of the core (Fig. 28b). The

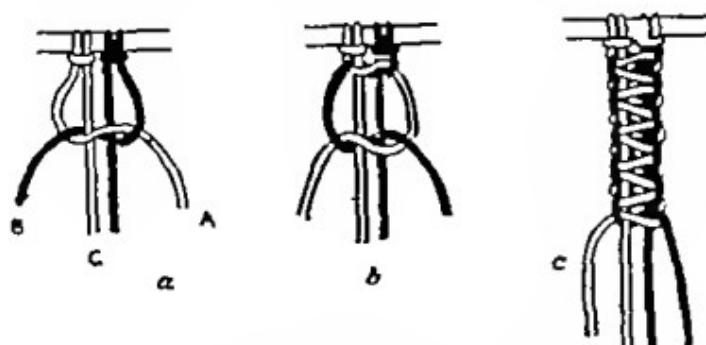


FIG. 28.—Formation of flat boatswain's knot. The significance of A, B, C, is explained in the text.

technique is repeated until the required length of knotting is formed (Fig. 28c)

Rolling Boatswain's Knot (Fig. 29)

This is made in much the same way as the previous knot a granny being substituted for the reef knot. The threaders are handled alternately but are always taken from the same side (Figs. 29a and b). This gives a spiral appearance to the knotting after about 5 knots have been tied (Fig. 29c).

If the left threader is used the knotting will roll to the right and vice versa. The work will twist completely over after two

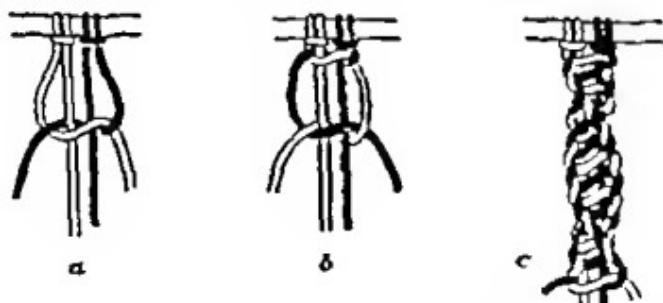


FIG. 29.—Formation of rolling boatswain's knot.

and a half knots have been made. To facilitate this the core strands are placed close together in the slotted bar of the frame.

The amount of material required for rolling boatswain's

knotting is approximately five and a half times the length of the finished work (See belt worked with boatswain's knots, page 186)

Split Boatswain's Knot (Fig. 30)

The knot consists of a flat boatswain's knot made up from some of the core and threader strands of two adjoining rows of knotting. It can be used as a linking device and is sometimes known as the split boatswain's weave. The inner strands A and B form the core while the original strands C and D act

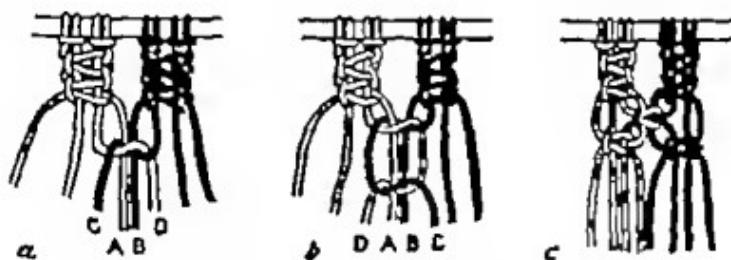


FIG. 30.—Formation of split boatswain's knot. The significance of A to D is explained in the text.

as the threaders. The two outer strands of both rows are left free (Figs. 30a and 30b).

Joining strands.—It is not practicable to join strands when working the split boatswain's knot. In the flat and rolling boatswain's knots the joins are made in the core. One of the core strands is substituted for the short threader end which is then employed in its place. After a few knots have been made a new length of material is paired with the short core end for about half an inch. The knotting is then carried on normally.

Slip Knot

When worked continuously this knot forms a length of rounded braid. Several of these braids can be joined together to make an attractive belt. The knots are either made in 2 strands of material approximately 5 times the length of the finished work, which are tied together with a reef knot or in a long strand twice the length of these strands. The knotting is begun in the first case by tying a slip knot close to the reef knot; in the second case the slip knot is made in the centre of the strand.

Fig. 31 shows the knotting technique. The tip of the right index finger is inserted into the loop of the slip knot (Fig. 31a) so as to hold it out tautly while the knot is held between the middle finger and thumb (Fig. 31b). The index finger is then bent down, so that its inner surface rests against the fixed knotting strand which is carried over it by the left hand (Fig. 31c). The strand is next converted into a 2nd loop (Fig. 31d).

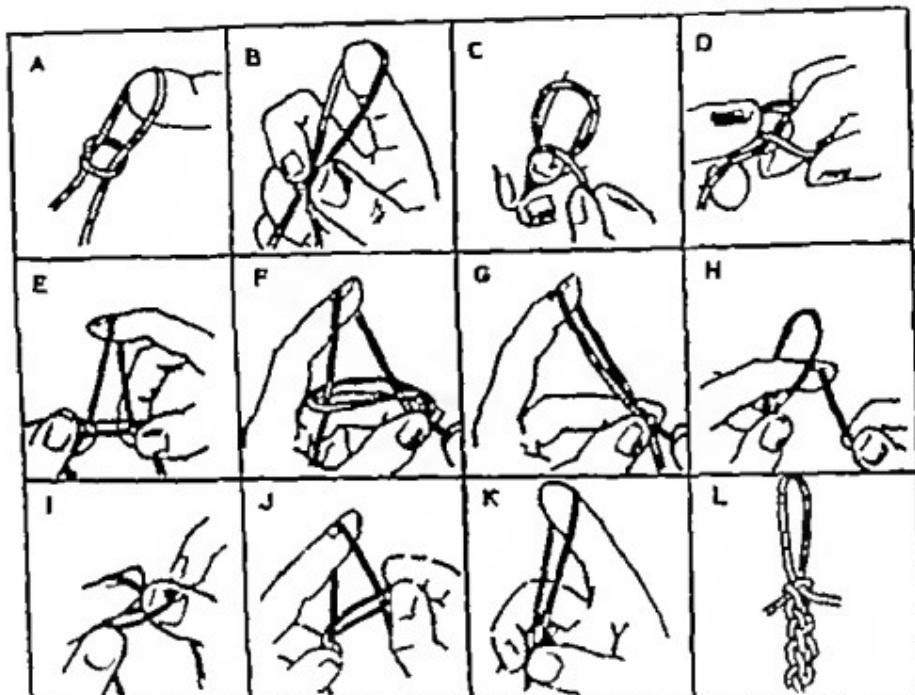


FIG. 31.—Technique of slip-knotting or finger-knotting. The significance of A to L is explained in the text.

The top of the original loop is pulled over the strand (Fig. 31d). It is then drawn off the finger tip as the right finger raises the strand (Fig. 31e). The left index finger is substituted for the right one in the new loop while the left thumb and middle finger hold the knot (Fig. 31f). The original loop is then drawn tightly round the new one by the right hand. In this way a 2nd slip knot is formed (Fig. 31g). The 3rd knot is made in the same fashion the left hand being chiefly employed (Fig. 31h k). Fig. 31l shows a length of the knotting.

The knotting is finished by passing the fixed strand through the last loop which is then tightened up as much as possible.

Finally the strands are threaded back through the knotting for a short distance and cut off close to the work.

Joining strands—If oddments of material are used it is necessary to join them. The end of the new strand is paired with the old end at a point in the knotting where the old length is about to be drawn through a loop. The double material is then used for about 2 knots.

3 Work with Knots

Belt worked with Boatswain's Knots

Material required

- (1) 1 huckle with cross bar 1½ to 2 ins. wide
- (2) No 5 macramé twine or some alternative such as belt cotton No 4 cotton twine, or No 2 or 3 American tubular banding

The exact amount of material required cannot be stated it depends not only on the length of the belt but on the width of the core and the diameter of the strands used. For example

as the diameter of No 5 macramé twine is less than that of belt cotton, slightly more twine than cotton is required to work a foot of knotting. In a belt the difference might amount to several feet of material.

Method of working—The belt is made up of parallel rows of flat and rolling boatswain's knotting which are linked together by split boatswain's knots.

Arrangement of the strands—10 single strands of knotting material, about 3 to 4 yds in length are looped on to the cross bar of the buckle with

FIG. 32.—Formation of the lark's head knot. The knotting strand is doubled and laid over the cross-bar of the buckle, so that the loop end hangs downward. The free ends are then passed forward through the loop and pulled tight. An alternative method of forming the knot is to reverse the position of the loop-end so that it projects upward behind the cross bar and then to thread the free ends back through it.

lark's head knots (Fig. 32) so as to make 20 single strands. The length of the strands must be varied or the joins will occur at the same level. It is better to work with comparatively short strands as suggested rather than to use very long



strands in an attempt to make a belt without joins. If this is done either the amount of material required is under estimated and a great many joins have to be made near the end of the belt or a considerable amount of material may be wasted.

Beginning of Knotting—The buckle is clamped in the jaws of the knotting frame and the core strands fastened to the slotted bar. One inch of knotting is then made the outer and central rows being worked with flat boatswain's knot and the other rows with rolling boatswain's knot. This is followed by alternate rows of split and flat boatswain's knotting. The rows of flat knotting are about three quarters of an inch long.

The symmetrical two-coloured effect of the split knotting is obtained by altering the normal working technique. Thus if the left threader is utilised first in making the initial knots the right threader is employed first in forming the last knot and vice versa.

Finishing the belt—The belt is finished off with a tapering end. 1 or 2 rows of split boatswain's knots are worked normally. The width of the belt is then gradually decreased by using 3 strands instead of 2 for every core. The 3rd strand is cut off when it has been covered. The finishing ends are clinched neatly into the knotting and glued into position.

Belt Worked with Slip Knot

Materials required—As for the first belt.

Meth. I of working—The belt is made up of cable length of slip knotting which are linked together by single row of flat boatswain's knots.

Beginning of Knotting—The strands are attached to the one bar of the buckle with hawks head knots. The initial slip knot of each pair of strands is made as close to the bar as possible. The amount of material needed for each buckle depends on the diameter of the strand and the formation of the knot as in the other belt. When No. 10 cable twine is used the length of the strand should be 5 times that of the finished belt.

Tool—Each link is formed by a double strand (A) of the belt material being woven through the cable row from one side to the other (the "bar"). Another double strand (B) is threaded through the entire cable length at the point where the first en-

of the 1st strand emerge. A flat boatswain's knot is then made between this length and the second one—the 1st strands are used as the core and the 2nd as the threaders. The threaders are then sewn through the 2nd cable length on either side of the core and another boatswain's knot is made between this length and the 3rd cable length. The process is repeated until single knots have been formed between the rows of knotting (Fig. 33h). The ends of the threaders are next passed through the final cable row and darned neatly into its

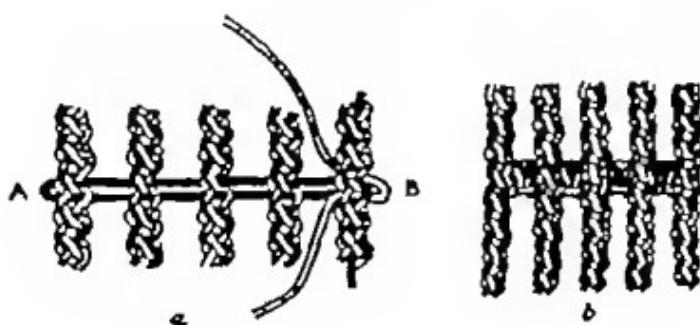


FIG. 33.—Formation of the cable links. The significance of the lettering is explained in the text.

outer surface—the core ends are treated in the same way on the opposite side of the belts. The ends are then glued into position.

Finishing the belt—The end of the belt is tapered off to a point by making the 3 central lengths slightly longer than the outer lengths. All the lengths are then finished in the same way as the end of the 1st belt. Finally the strands are used to sew the lengths closely together for about $1\frac{1}{2}$ to 2 ins from the tip of the belt.

Seating

Remedial Use

Indications—Intermediate phase of recovery from impaired function of the upper limb following disease or injury

Primary remedial purposes—To strengthen the muscles and mobilise the joints of the upper limb; to strengthen the grip and to increase the range of flexion of the fingers.

Craft analysis—The craft consists of the seating of stools and chairs with such materials as seagrass and cord. The weaving method of seating is of great remedial value as the

TABLE DEMONSTRATING MANNER OF ADAPTING SEATING FOR SPONTANEOUS MOVEMENTS

(The right arm only is referred to in this Table)

Joint	Movement	Point from which Seats are introduced	Position of Patient & Specific Movement is performed
Gleno-humeral	Abduction	Left rail	Opposite stool, with R. arm to side ; elbow joint flexed to 90° ; forearm held in pronation
"	Adduction	Right rail	Opposite stool slightly on its left. Arm and forearm as above
"	Flexion	Front rail	As for abduction of gleno-humeral joint, but forearm in mid position
"	Extension	Back rail	As above
"	Outward rotation	Left rail	As for abduction of gleno-humeral joint
"	Inward rotation	Right rail	As for adduction of gleno-humeral joint
"	Elevation of the humerus above the level of the shoulder (continued abduction of gleno-humeral joint)	Left rail	As for adduction of gleno-humeral joint
"	Elevation of the humerus above the level of the shoulder (continued flexion of gleno-humeral joint)	Front rail	As for flexion of gleno-humeral joint
Elbow	Flexion	Back rail	As for abduction of gleno-humeral joint, but forearm in mid position
"	Extension	Back rail	As above
Radio-ulnar	Supination	Left rail	As for abduction of gleno-humeral joint, but forearm supinated
"	Pronation	Right rail	As for adduction of gleno-humeral joint, but forearm in mid position
Wrist	Flexion	Right rail	As for abduction of gleno-humeral joint, but forearm in mid position
"	Extension	Left rail	As for adduction of gleno-humeral joint, but forearm in mid position
"	Abduction	Right rail	As for adduction of gleno-humeral joint
"	Adduction	Left rail	As for abduction of gleno-humeral joint

- (c) A $\frac{1}{4}$ in. diameter dowel rod, a little longer than the width of the stool or chair frame
- (d) A hammer sharp knife pair of pliers medium and fine sandpaper brush and old rags for staining

Constructional Work with Seating

Instructions are given here for seating a stool with a 7-group woven pattern. Before the seating is started, the frame should be rubbed down with sandpaper.

Materials required

- (a) Square stool frame Rail top $10\frac{1}{2}$ ins square height $10\frac{1}{2}$ ins
- (b) Medium seagrass or sisal Amount required can be based on the fact that approximately $1\frac{1}{2}$ lb of medium seagrass are used in seating a stool top $12\frac{1}{2}$ ins square

7 Group Woven Seat

Stage 1 Binding—A long length of seagrass is wound into a ball. It is then bound round 2 opposite seat rails the upper strands being carried over the dowel rod which is placed across the frame (Fig 34). The rod keeps the strands at the correct tension for the secondary weaving process. In binding a knot is first made in the free end of the seagrass and this is nailed securely to the inside of the front rail at its junction with the left leg. The seagrass is brought forward under the front rail and then carried over it and the dowel rod to the back rail close to the left back leg. It is passed round the rail to the under surface of the frame and across to the front rail again the grass being kept taut throughout. The process is repeated until 7 strands have been bound in turn over the top of the frame and 6 underneath and the end of the seagrass has been brought over the back rail.

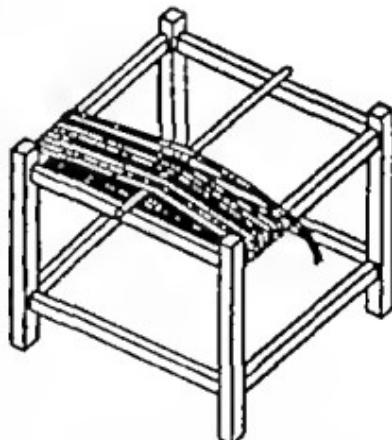


FIG 34.—Binding the first stage of seating. Three strands are shown instead of the seven suggested in the text.

A spacing technique to divide up the strands into separate groups of 7 is then employed. The seagrass is wound once

round the back rail and is then passed forward under the frame to the under side of the front rail where the same process is repeated. Fig. 34 illustrates the method of grouping when only 3 strands are used. The binding is continued until the back and front rails have been completely covered and the ending matches the beginning. The dowel rod is then removed and the 2nd stage of the seating is begun.

If the same coloured seagrass is used as in the 1st stage the finishing length of seagrass is employed to start the weave. If a different colour is required this length is cut off and its free end nailed to the inside of the back rail.

Second stage Weaving—Secondary groups of 7 strands are woven alternately under and over the original groups and

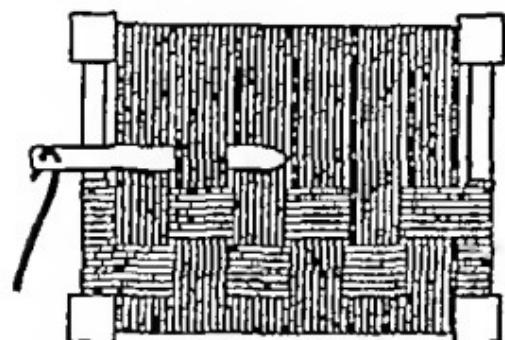
around the uncovered seat rails in the same way as before (Fig. 35) The wooden needle is used to facilitate the threading process.

If the length of sea grass from the 1st stage is employed it is passed behind the inner surface of the right back leg and brought out under the right uncovered rail at the point where it joins the leg. When a new length

FIG. 35.—Weaving the second stage of seating. The secondary groups of strands are woven alternately over and under the original strands. (Figs. 35 and 36 form a group.)

of seagrass is used it is either tied on to the old length with a reef knot or a knot is made in its free end and this is nailed to the inside of one of the frame corners. Ideally the under surface of the seat should be woven in the same manner as the top. A modified method consists of passing the strands under a few groups instead of all.

During the weaving of the last 2 or 3 groups the steel needle is used, as the initial strands become too tight to allow the wooden needle to pass easily. Because of the tension a pair of pliers will be found extremely useful in gripping the needle or the end of the seagrass and pulling it through the groups. When the weaving is finished the end of the seagrass length is cut off and a knot made near the end. This is nailed



to the under surface of the terminating rail and the surplus end threaded between the initial strands and the rail so as to create an invisible finish.

Joining seagrass—If the seagrass needs to be joined at any stage in the seating the two ends are spliced together on the under surface of the seat as shown in Fig. 36. The free ends

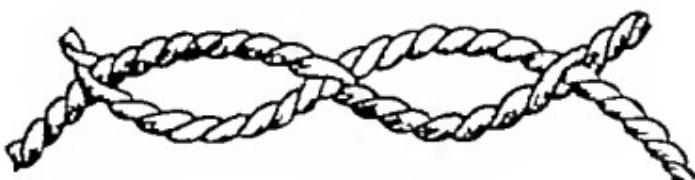


Fig. 36.—Method of joining two ends of seagrass.

can be either tucked into the seat or cut off at a little distance from the splicing points. Seating-cord or sail is best joined with a reef knot.

Finishing off the frame—The frame can be stained enamelled or waxed. Whatever finish is chosen the frame must be rubbed down with fine sandpaper to clean the wood for it will have become dirty from constant handling.

Intermediate Work—Fretwork

Remedial Use

Indications *Hand saw*—Intermediate phase of recovery from impaired function of the forearm hand and fingers due to disease or injury. *Treadle saw*—Early and intermediate phase of recovery from impaired function of the leg and foot due to disease or injury. Intermediate phase of recovery from lesions of the external popliteal nerve.

Primary remedial purposes *Hand saw*—To strengthen grip and to increase the range of flexion of the fingers. *Treadle saw*—To strengthen the plantar flexor and dorsiflexor muscles of the ankle joint to mobilise the ankle joint.

Craft analysis—Fretwork involves the use of a fretsaw which is chiefly employed to cut thin wood into special shapes as in model making. There are 2 main types of fretsaw the hand-saw and the treadle saw.

Hand-Saw

The sawing is carried out at a special cutting table the worker operating the saw frame with the right hand. The right elbow joint is flexed to a right angle and the forearm is held in mid position. The frame is moved continuously up and down by very small range movements of flexion and extension of the elbow joint.

Remedial application—The saw frame should be used by the affected hand. If the left arm is involved and the patient right-handed the work must be simple or he will have difficulty in controlling the saw.

Flexion of the fingers—If flexion of the fingers is limited the size of the handle can be padded to suit the degree of movement the padding being gradually reduced as flexion increases.

Development of grip—As the saw handle must be gripped strongly throughout the sawing which involves sustained contraction of the flexor muscles of the fingers it is important to select work which does not entail continuous sawing. One of the best occupations for this purpose is making jigsaw puzzles. If the pieces are kept relatively small and the puzzle built up as it is cut the work will provide alternate periods of contraction and relaxation for the flexor muscles of the fingers.

Treadle Saw

The saw blade is operated by the treadle plate. This is moved rapidly up and down by the feet one foot being placed a little in front of the other one. Both hands are employed to hold the wood against the saw blade. The treadle is pressed down by wide range plantar flexion of the forward ankle-joint and levered up again by almost full range dorsiflexion of the rear ankle-joint.

Remedial application—The saw can be operated more efficiently if the area of the treadle plate is increased by fastening a sheet of wood to its upper surface.

Plantar flexion and dorsiflexion—If possible the machine should be operated by the affected leg only.

External popliteal paralysis—The work should be carried out naturally the sound leg assisting the affected one.

Constructional Work

Jig saw puzzle—The picture is pasted on to a piece of $\frac{1}{8}$ in thick plywood. To avoid stretching the paper the paste is brushed on to the wood and the picture then pressed down on to it. Pressure is applied with a piece of clean rag from the centre of the picture outwards to prevent the formation of wrinkles and to disperse air bubbles. If a very large picture is

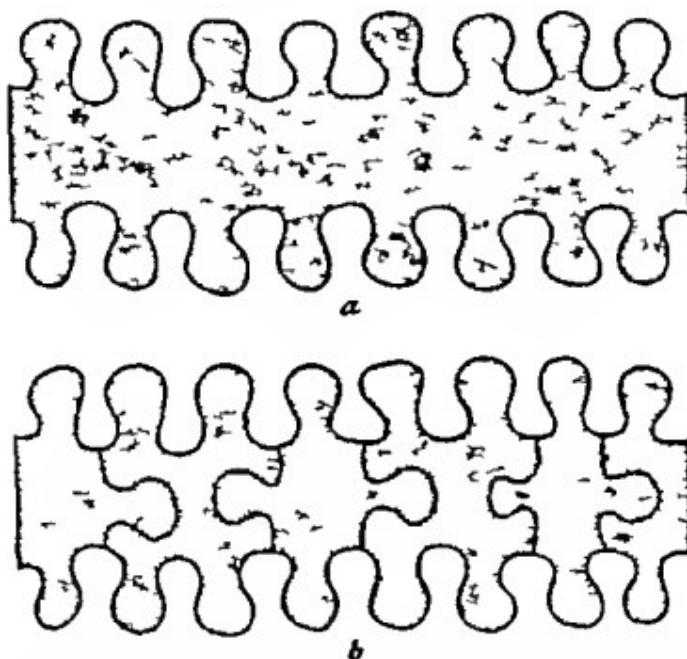


FIG. 37.—Method of cutting interlocking shapes for a jig-saw puzzle. The significance of (a) and (b) is explained in the text.

used it is advisable to roll it on to a round ruler and then to roll it off on to the wood.

When the paper is quite dry the wooden margin projecting round the border of the picture is trimmed off. The puzzle is then ready for cutting. It is best to dispense with a pattern of interlocking shapes as this necessitates tracing lines on the picture which tends to spoil the appearance of the finished article. Instead the picture is cut transversely into a number of shaped strips as illustrated in Fig. 37a. By cutting across these strips as indicated in Fig. 37b any number of clear-cut interlocking puzzle pieces can be made with ease.

**GARDENING AS SPECIFIC OCCUPATIONAL THERAPY
(LIGHT INTERMEDIATE AND HEAVY WORK)**

Gardening can be used in all phases of recovery from impaired function of the limbs and trunk due to disease or injury. Some of the more strenuous tasks such as digging and lawn rolling are especially useful as final activities for sedentary workers.

Light Work Hoeing, Raking and Hedge Clipping

Dutch Hoeing and Raking

Indications—Intermediate phase of recovery from impaired function of the upper limb due to disease or injury.

Primary remedial purposes—To strengthen the abductor and adductor muscles of the shoulder joint and the flexor and extensor muscles of the elbow joint to increase the range of flexion and extension of the elbow joint.

Remedial application

Upper limb—The work can be performed naturally if the right arm is affected. The patient can turn and reverse the position of his hands so that the work is localised to the left arm if this be the affected limb.

Spine—Raking can be used as a gentle exercise for the extensor muscles of the spine and hip joints if the trunk be allowed to take part in the forward and backward movements.

Hedge Clipping

Indications—Intermediate and late phase of recovery from impaired function of the upper limb due to disease or injury.

Primary remedial purposes—To strengthen the abductor and adductor muscles of the shoulder joint and the flexor and extensor muscles of the elbow joint.

Remedial application—Hedge clipping can be employed to exercise one or both arms. Little or no special adaptation is necessary.

Shoulder and elbow-joints—For cases requiring abduction and adduction movement side clipping is used the affected arm being employed to work the upper shear handle. For elbow flexion and extension the affected arm should operate the lower

shear handle in side clipping or the work should be restricted to the top of the hedge

Intermediate Work—Lawn Mowing and Rolling

Lawn Mowing and Rolling

Indications—Intermediate phase of recovery from impaired function of the spine due to disease or injury. Late phase of recovery from impaired function of the lower limb due to disease or injury.

Primary remedial purposes—To strengthen the abdominal muscles and the extensor muscles of the lower limb and spine to develop the grip.

Remedial application—Mowing and rolling can be carried out normally for both leg and trunk cases the mower being used as a progression on the roller if the grass is long enough to offer considerable resistance to the mower blades. The strength of the occupation can be progressed by doing the work on sloping ground.

Heavy Work—Digging

Digging

Indications—Late phase of recovery from impaired function of the spine and limbs due to disease or injury.

Primary remedial purposes—To strengthen the flexor and extensor muscle groups of the spine and the extensor muscles of the knee- and hip-joints to increase the range of pronation and supination of the forearm to strengthen the grip.

Remedial application

Spine and pelvis—To obtain a balanced effect the patient should use his right and left legs alternately on the spade for short periods. In digging across a piece of ground this can be achieved naturally if the right leg is employed while working from left to right and the left when digging from right to left.

Lower limb—The affected leg should be used on the spade. The normal degree of extension of the knee and hip joints is considerably increased if the patient does not flex the trunk too far when driving the spade into the ground.

Hand and forearm—The affected hand should grip the handle of the spade.

DOMESTIC WORK AS SPECIFIC OCCUPATIONAL THERAPY (LIGHT INTERMEDIATE AND HEAVY WORK)

A wide range of ordinary household duties can be used successfully in all phases of recovery from impaired function of the upper limb and trunk due to disease or injury. The more strenuous work, such as floor polishing is particularly suitable as heavy occupational therapy for women patients.

Light Work—Sweeping and Dusting

Sweeping

Indications—Intermediate phase of recovery from impaired function of the upper limb due to disease or injury

Primary remedial purposes—To strengthen the abductor and adductor muscles of the shoulder joints and the flexor and extensor muscles of the elbow joints to strength the extensor muscles of the spine

Remedial application

Upper limb—The work should be carried out naturally the affected arm guiding the end of the handle

Spine and pelvis—The sweeping stroke should be increased to enlarge the scope of the spinal movements

Dusting

Indications—Intermediate phase of recovery from impaired function of the upper limb due to disease or injury early and intermediate phases of recovery from impaired function of the spine due to disease or injury

Primary remedial purposes—To increase the range of movement at the shoulder joint and joints of the shoulder-girdle to provide movements of the trunk in a stooping posture to strengthen the extensor muscles of the spine and hip joints

Remedial application

Upper limb—The work should be carried out by the affected limb the movements being made as large as possible

Spine and pelvis—Low dusting should be used, the work being performed by each arm for a short period so as to produce an even-sided effect

Intermediate Work—Scrubbing

Scrubbing

Indications—Final phase of recovery from impaired function of the upper limb due to disease or injury

Primary remedial purposes—To strengthen the muscle groups of the shoulder joint and trunk to increase the range of movement of the shoulder joint to strengthen the abductor and adductor muscles of the wrist joint

Remedial application

Upper limb—The scrubbing should be carried out by the affected limb and performed at different levels so as to produce various types and ranges of movement

Spine—Floor scrubbing on the lines suggested for floor polishing by hand (see below)

Heavy Work—Polishing and Laundry Work

Polishing

Indications—Final phase of recovery from impaired function of the upper limb and spine due to disease or injury

Primary remedial purposes—To strengthen the muscles of the upper limb and trunk to increase the range of movement of the shoulder joint and spine

Remedial application

Upper limb—The work should be performed by the affected arm In using a floor polishing brush progression in strength is achieved by increasing the weight of the polisher progression in range by fitting a long handle and instructing the patient to hold the ends Floor polishing brushes vary in weight from 6 to 26 lb

Spine and pelvis—Hand polishing should be carried out for a short period with either hand to procure a balanced exercise effect It is possible to bring about localised spinal movements by modifying the direction of the strokes when the patient is on his hands and knees Long polishing strokes should be made in order to increase the normal trunk movements This increase follows automatically when a long handled polishing brush is swung sideways

Washing Wringing Mangleing and Ironing

Indications—Intermediate and final phases of recovery from impaired function of the upper limb and spine due to disease or injury

Primary remedial purposes—To strengthen grip to increase flexion of the fingers to strengthen the chief muscle groups of the upper limb and spine

Remedial application—Little modification is necessary as much of the work is bilateral. Where the action tends to be chiefly unilateral the occupation should be arranged so that the affected limb is employed more than the sound one. Washing is particularly beneficial for finger and hand injuries associated with laceration as the immersion in the warm water helps to soften scar tissue. It is important that the water should be kept warm throughout the occupation period.

CHAPTER 11

MEDICAL PRACTITIONERS AND PHYSIOTHERAPY

PHYSIOTHERAPISTS have always been anxious to receive from the medical profession technically correct and detailed instruction. The absence however of any comprehensive undergraduate instruction in methods of physiotherapy makes it impossible for the majority of practitioners to provide the physiotherapists with what they have wanted. The points made here commonplace though they are to those with technical training whether as physiotherapists or as specialists in physical medicine will it is hoped, help to further the collaboration so essential between physiotherapists and the growing body of medical men and women who wish to prescribe and supervise physical techniques accurately.

THE DIRECT CURRENT

There is probably more confusion among practitioners about this current and its uses than about any other physical treatment. The confusion arises partly from the nomenclature that has been attached to various modifications in common use.

It is possible to bring these into some sort of common order by means of the following:

Terminology

D C stands electro-technically of course for direct current.¹ It is therefore the proper term to use and is in fact the one employed by physicists. It lends itself immediately to simple additions to indicate polarity strength and whether the current is to be interrupted surged or used with any specification. It

It should be noted that a small but growing school of thought favours the use of the term "Z.F." (zero frequency) to replace "D.C." This has much to commend it, since as the frequency of A.C. is reduced to the limit it becomes zero—i.e. Z.F. = D.C. "Z.F." voltage for example is a much happier term than "D.C. voltage" (i.e. direct current voltage), just as "Z.F. current" may be preferred to the term "D.C. current" (i.e. direct current current) so often met with.

should replace older terms especially Galvanism if for no other reason than that it provides a proper and agreed technical language. It is the form a medical practitioner would use who made wireless his hobby.

Galvanism

This means the use of the direct current. When used alone the term is practically meaningless for it may cover any of the modifications given below. It is a term that should really belong to the past.

Labile Galvanism

This means a little more than 'Galvanism' for it implies that the current is interrupted or increased and decreased at intervals. It is technically inadequate for it gives no information about the polarity employed, or the method or frequency of interruption. It should therefore never be used in discussion of treatment with a medical practitioner.

Stabile Galvanism

This implies that the direct current is used without interruption or variation. It is a misleading term for it may include the use of the physiological effects of the positive or negative poles or their employment in ionisation the physiotherapist advocated being used.

Anodal Galvanism

This term implies that the positive electrode of the direct current is being used for its physiological properties at the site of active treatment. The physiotherapist should not say that she recommends the use of this current unless at the same time she gives the millampereage and duration of treatment.

Kathodal Galvanism

The same remarks apply here as for anodal galvanism except that the term implies that the negative electrode is the one in clinical use.

Surging Galvanism

This is used to indicate that the direct current is increased gradually and smoothly to a maximum and decreased equally

gradually and smoothly in a sinusoidal manner usually by some electro-mechanical device. The term is of little value unless an indication is given of such technical details as the polarity of the electrode at the site of treatment the maximum current used and the periodic frequency.

Interrupted Galvanism

Here the direct current is interrupted by make and break throughout the treatment. The term is valueless as a guide to accurate treatment without information as to the polarity employed the intensity when the current is made the frequency of interruption and the duration of treatment. It is only by the use of scientifically correct terminology that the medical practitioner can gain confidence in physiotherapeutic techniques.

Ionisation

This is a generic term meaning that treatment effects will rely upon the introduction of a known therapeutic ion. It is valueless without detail as to the polarity and the ion to be used. As a result of laxity in giving details of techniques it has become not uncommon for ionisation to mean iodine ionisation to the medical practitioner.

Iontophoresis and Cataphoresis

These terms were formerly applied to the direct current when this was used for ionisation. They are no longer required and should not be used by physiotherapists.

APPARATUS

Medical practitioners frequently become confused by many of the terms used by physiotherapists. This is due to the fact that manufacturers have introduced a diversity of names for types of apparatus that merely deliver the same basic current or combination of currents which electro-technically are known by simple terms. The best example is that type of apparatus which includes the direct induced and sinusoidal currents. Apparatus of this kind has been known by names such as Multostat, Plurostat, Pantostat or Combined Table. When the

There has a precise meaning, for the technique has been described in great detail by Sir Morton Smart on many occasions, and is entirely different from saying it is so common that a patient is having Morton Smart treatment. Indeed the simple word *Electro*- is frequently found on a treatment prescription, though the great majority of medical men even a week must be innumerate in facilitating.

Of all galvanic currents it is the better-known apparatus that contract muscles. I would think in common—nearly that each one is capable of producing consistent cramp-like contraction of muscle sufficiently whereas direct current and certain other techniques will not produce sustained cramp or tetany.

Even then, however, there is its disadvantage—the electrical power supply. It isn't used by electro-physiologist to have a power supply. I would derive from Michael Faraday's law that is something connected with the name of him. In 1831, Dr. H. V. C. G. M. Faraday's Medical Research Committee produced a report which was legitimate to use to contract muscle by applying an electric current and to cause contractions of muscle supply.

What
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THE ELECTRO-MAGNETIC SPECTRUM IN PHYSIOTHERAPY

Most medical practitioners are now familiar with the type of case that should be submitted to treatment by the shortest of the therapeutic waves found in the electro-magnetic spectrum namely radium and deep X-ray they are also familiar with the fact that wireless waves form part of this spectrum though widely separated from the former The medical practitioner will, therefore be able more readily to appreciate the scope and uses of the other parts of the spectrum that are used in treatment

It may not be out of place to recapitulate here some of the agreed and well known facts about these various sections of the spectrum

In that part of the spectrum in which ultra violet light is produced certain physical and physiological facts of interest to the medical profession have now been established

(1) In the table (page 208) 2 000 to 4 000 Ångström units columns 3 to 7 the various degrees of penetration and absorption for the different wave-lengths of ultra violet light are clearly shown.

(2) Ultra violet light produced in quartz tubes such as are used in the ordinary mercury vapour lamps forms a certain amount of ozone which is irritating to the respiratory passages It does this because the mercury vapour arc contains a wave length of 1 850 Ångström units which is essential in the production of ozone and to which quartz is transparent The material surrounding the arc (a special Corning glass) in the lamps used in America for reducing air borne infection in wards and operating theatres is opaque to this wave-length

(3) The physiological action of ultra violet light is due to conversion of the ergosterol in the skin into vitamin D Ergosterol is an impurity of cholesterol, the latter being one of the constituents of sebum in the skin The potency of this effect is well illustrated by the fact that calciferol (pure vitamin D) is made commercially by the irradiation of ergosterol by ultra violet light

4 It has been proved that ultra violet light aids the absorption in the body of calcium and phosphorus

5 Contra indications to ultra violet light are during X-ray

they are so subjected to radiation either by the removal of the blankets or by their blankets becoming hot the adverse effects noted are in all probability due to irradiation by the shorter infra red rays whereas the beneficial effects come from the conducted and conveyed heat or at most from long waves in the region of 100 000 Ångström units

Recent experiments have established that patients suffering from shooe who require heat respond better when this is presented to the body by means of moving conduction and convection currents of air at temperatures equal or nearly equal to normal skin temperature. The application of what may be termed negative heat i.e. cold (in specialised cases) belongs to the sphere of surgical nursing rather than to that of the physiotherapist.

Infra red irradiation before ultra violet treatment acts as a sensitiser and increases the erythema reaction. Given immediately after the ultra violet rays so as to cause an infra red erythema it diminishes the ultra violet ray erythema and may be used as a remedy in the case of an accidental overdose of the latter. Once the ultra violet erythema has begun to appear infra red rays only tend to aggravate the condition.

Diathermy

Very considerable confusion still exists on this subject not only among medical men but also among physiotherapists. A restatement of the simple facts in the light of advances in wireless technique will be of value.

When diathermy was first introduced to the medical profession spark generators were used. With such apparatus the high frequency output is taken to conducting electrodes in direct electrical contact with the skin of the patient. This technique does not permit control of the path taken by the current otherwise than by suitable positioning of the electrodes on the body surface. The depth at which tissue-heating takes place will be entirely dependent on the nature of the local tissue.

Later the introduction of valve-operated generators permitted the use of considerably higher frequencies (shorter wave lengths) which in turn made practicable the application of the current to the patient by means of condenser electrodes. Here no direct electrical contact exists between the electrodes.

and the patient high frequency energy is applied through the medium of an electrostatic field. Some control of the distribution of the current is thus made possible by modifying the distribution of this field. This is done in practice by varying both the position of the active electrodes and their spacing from the skin. Alternatively high frequency currents may be induced within the tissues by bringing them within the inductive field of a coil. This is the principle commonly known as inductotherapy.

The wave form produced by a valve generator differs considerably from that described above for spark apparatus. Ideally it should be a continuous wave of high frequency oscillations of constant frequency and amplitude. Even with the better-class commercial apparatus employing rectified and smoothed power supplies the design of the generating and patient circuits do not permit a stable frequency. Varying patient loads and movement of the patient (including respiration) react upon the generator causing wide variations in the output frequency. It is possible to design apparatus free from this latter defect.

In the past it has been common to speak of 10 6 or 3 metre short wave apparatus as short-wave or ultra short wave apparatus. Such expressions should cease especially when it is remembered that at no distant date apparatus of centimetre wave length will probably be in common use. It cannot be too clearly realised that all existing commercial models sold as apparatus of 10 6 or other wave-lengths produce many other wave lengths simultaneously with the one that is their fundamental wave-length. This again is on account of their basic design which generates many harmonics of the fundamental wave length.

In modern short wave treatment the part to be treated is placed in the oscillating electric field. There are two fields into which the part can be inserted, namely the inductive (electromagnetic) field or the capacitive (condenser or electrostatic) field.

It is now possible with these facts before us to remove much of the mystery from the nomenclature. *Short wave diathermy*, *ultra short wave diathermy* and *inducto-thermy* are merely names and not scientific statements of the currents or descriptive of the circuits.

The preceding paragraphs of this chapter have dealt exclusively with electro-therapeutical methods as they jointly concern the physiotherapist and the medical practitioner. There are however other aspects of the work carried out by physiotherapists such as massage hydrotherapy exercises and occupational therapy that require some brief consideration.

MASSAGE

Although massage has been in use for so many centuries that its origin is lost in antiquity it suffers at intervals from alternations of praise and condemnation. It is just emerging from a period of this latter state. The physiotherapist should therefore be particularly careful not to claim too wide a field for its uses and she must face the fact that some conditions are known by experience to be made worse by it. For instance it is legitimate for the physiotherapist asked to treat any acute form of neuritis by massage to safeguard herself and protect the practitioner by asking for instructions as to her procedure in the event of any increase of symptoms. If despite the practical certainty that acute neuritis will be made worse by any form of massage this has been prescribed then only the slowest and most rhythmical form of offlourage called by the French glneokinesis should be used.

Again it cannot be expected that any form of massage could actually cure fibrosis of whose basic cause so little is known. Nevertheless massage can undoubtedly assist in the better metabolic exchanges of the part during such time as the physician eliminates the basic cause or nature has time to produce her own remedy.

HYDROTHERAPY

Hydrotherapy is also a time-honoured field for the physiotherapist. Full hydrotherapeutic measures can only be applied in special institutions or spas and are therefore not within the scope of this book. It is however worth noting that simple hydrotherapeutic measures such as can be instituted at home

or in small departments aim at producing mild skin stimulation and sweating

Good clinical results can be obtained in suitable cases by intelligent use of the ordinary hromo bath hot towels or the full blanket bath designed to produce sweating

PRINCIPLES OF SELECTION

The proper approach to the selection of electrical methods in the treatment of any disease or injury should be to form a conception first of the underlying physiological and pathological condition, and then of the physical alterations that are necessary to restore the normal physiological state

The flow of lymph may be stopped nerves may be bruised muscles may be in spasm or toneless the blood supply may be deficient or excessive infective processes may be active or have left their mark sweating may be absent the metabolic activity of the body may be diminished or excessive and vitamins or endocrines may be deficient

1 The Restoration of Lymphatic Flow Relief of Pain and Muscle Spasm

For this the current of choice is the direct current the positive pole acting in the direction of the lymph stream This procedure is based on established physiological grounds Thus it can be demonstrated that when the direct current passes from one area of the body to another the following effects take place at or near the positive pole

(a) Lymph and body fluids generally tend to pass from the positive to the negative pole This is obviously useful where any congestive lymph condition exists It is equally obvious that the less coagulated the lymph i.e. the sooner the current is given the better

(b) The sensitivity of nerve endings is diminished at or near the positive pole of the direct current It is therefore the current of choice where nerve endings have been bruised for it can be relied upon to bring relief of pain Obviously however this can only occur if the condition that caused the pain is not of a nature that is bound to persist after application of the

current e.g. a splinter of shell or fragment of bone maintaining pressure on a nerve

(c) The currents of injury are of a kind that are largely balanced out by this current

From the foregoing it is clear that the direct current provided that it can be suitably applied soon enough after the injury is particularly useful in recent injuries especially minor injuries for this current tends to normalise the three outstanding features of any minor injury namely lymph congestion bruised nerve endings and muscle spasm

2 Restoration or Increase of Muscle Tone

For this the methods of choice are rehabilitation exercises and the currents capable of causing the muscles to contract painlessly (e.g. faradic and sinusoidal currents). Physical medicine consultants and orthopaedic surgeons throughout the world have shown that carefully graded exercises are probably the finest method of all for restoring muscle tone. This is a doctrine that has been preached for over a hundred years but war has extended its application to the debilitated. Although the benefits of muscle re-education by voluntary effort cannot be questioned there are a number of conditions in which this voluntary effort can be enhanced by electrical currents with definite and genuine benefit. The reason for this is that the faradic and sinusoidal electrical currents can be made to cause muscles to contract painlessly and with greater physiological economy.

3 Restoration of the Circulation of Blood

This is more difficult to deal with simply for the circulation may only be hampered as in a sprain or strain or it may be entirely cut off as a result of infection diabetic gangrene frost bite injury or over long application of a tourniquet.

It has already been seen that the direct current can be applied to the restoration of lymphatic flow and to the relief of pain and muscle spasm and therefore that it can do something if only indirectly to help in the restoration of blood flow especially in minor injuries.

In pneumonia there is a wide area of blood stasis at the

margins of the consolidated areas however the blood vessels require but little help to restore their function. Here therefore is a field for the short wave with its power of warming (and therefore expanding) deeply seated tissues. Again in carbuncles and boils the almost specific effect of short wave diathermy is due to the action of the heat on the vessels at their circumference enabling the processes of repair to proceed more easily.

The selection of the method of treatment will depend partly on the position and partly on the extent or duration of the impaired circulation.

Radiation from sources of heat giving out rays below 50 000 Ångström units such as radiant heat infra red and shock cradles should not be employed in cases requiring resuscitation whether by heat or by cold. The employment of suitably warmed or cooled convection currents of air provides a better physiological environment than the use of the old types of radiant heat or infra red cradles.

4 Removal of the Deleterious Effects of Infection

It is an age long rule that fomentations hot soaks and similar applications of heat in the presence of inflammation are beneficial. The current of choice is therefore clearly the short or long wave diathermy with, as a poor second, infra red or radiant heat. With knowledge as to the application and method of propagation of short-waves in the body it is possible to bring heating effects even to deep-seated organs. But here also there is one general rule for these currents with some penetration and that is that they should not be used except in very weak doses where pus is shut up and has no means of exit unless it is particularly wished to bring this to a head. A useful example is the treatment of carbuncles and boils by short wave.

Another aspect of this removal of the deleterious effects of infection arises where the infection has been established as in chronic wounds or discharging sinuses. In these conditions there are too many well-established organisms and too poor a blood supply in the wound cavity or the sinus wall for the natural processes of repair of the body to be effective. As a first step it is therefore important to diminish the number of organisms and improve the blood supply. Ionisation with one

of the active antiseptic ions such as zinc silver or iodine can be used with great benefit furthermore as the direct current produces alkali at its negative pole and this in its turn, tends to wash away coagulated mucus it is a sound practice to start with collosol iodine and after a few treatments to change to colloidal silver with all the advantages of the decongestive positive

5 Increase of Sweating and Activity of the Skin

The skin is an important excretory organ of the body In a number of conditions the skin becomes sluggish particularly in those disposed to gout and in women at the menopause For sweating to be beneficial it is essential to raise the body temperature some 2° or 3° F while this is taking place The pyretic bath designed by the late Dr Wilde may be used for this purpose This is simply a heated cabinet with means for preventing the loss of heat and for keeping the patient in a moist atmosphere Sweating at a raised temperature can by appropriate technique be secured with a simple infra red or radiant-heat cradle as found in all hospitals It is an invaluable help where the metabolic activity of the body is sluggish Brine baths are also useful for increasing metabolism and skin activity

6 Increase of Supplies of Vitamin D

For this the treatment of choice is irradiation by ultra violet light for this activates the ergosterol of the skin turning it into vitamin D which in its turn promotes the absorption of calcium and phosphorus

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